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The Influence Attitude has on Student Achievement in a Developmental College Algebra Course

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Dissertation submitted to the
College of Human Resources and Education
at West Virginia University
in partial fulfillment of the requirements
for the degree of

Doctor of Education
In
Curriculum and Instruction
Minor
In
Mathematics

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Morgantown, West Virginia
2004

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ABSTRACT

The Influence Attitude has on Student Achievement in a Developmental College Algebra Course

Michael T. Wilder

Faced with unacceptable failure rates in introductory mathematics courses, institutions of higher learning are incorporating methods of placing students into their math courses based upon the students preexisting math knowledge or skills. West Virginia University is no exception and is currently incorporating a combination of ACT/SAT scores with an internal placement exam to properly place students in the appropriate math course. This method is not working in that failure rates continue to rise in spite of continual increases in placement requirements. Based upon antidotal evidence by experienced faculty over a ten year period it became clear that factors other than prerequisite math knowledge were influencing the success of students. This study researched the influence which attitude has upon developmental algebra students at West Virginia University.

A quantitative research tool in the form of a scanable attitude survey was devised and piloted the semester before the actual study was conducted. Access was granted to all aspects of the student's course grades allowing all types of classroom behavior to be tracked and monitored. The attitude survey was administered twice during the semester to all enrolled students (aprox. 200), attitudes were quantified, recorded and correlated with overall exam grades. Concurrently a special grouping procedure was utilizes to study the correlations within specific subgroups within the main course population.

To further triangulate the determination of attitude, a qualitative interview process was developed and also piloted the semester before this study. The qualitative interview protocol addressed documented factors of attitude. The interview process was performed concurrently with a sample population from within the same main group of students as was the attitude survey. All interviews were audio recorded and transcribed.

Statistical reliability analysis and all correlations were run using established procedures within the field of survey statistics. Quantitative results were compared to qualitative interviews for specific students. This study found that there exists a strong correlation between observed attitude and course outcomes in this developmental course, for particular subsets of students within the main course population.

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CHAPTER 1

1.1 INTRODUCTION

Of chief concern at most institutions of higher learning is the placement of students into the appropriate courses. This is especially true in mathematics because most if not all college level mathematics courses require some amount of prerequisite math knowledge to be successful. Based upon this fact, most institutions establish a method by which they evaluate the students existing knowledge of mathematics, before placing the student into a math course. The most common method of evaluating a student's mathematical knowledge or ability is through diagnostics testing. Many institutions use the mathematics component of the ACT/SAT tests as their diagnostic test. In addition to the ACT/SAT math scores, many institutions have developed custom diagnostic tests to aid in the placement process.

There are several studies which support placing students based upon demonstrated mathematical ability, most notably Schiefele and Csikszentmihalyi (1995). In this study it was found that for those students who demonstrate superior mathematical ability and/or knowledge, diagnostic tests are a dependable predictor of student achievement. A correlation between test performance and course success of above .56 was found for the upper 20 percent of the test scores. The lower 80 percent demonstrated weak to no correlations.

In 1994, with a student population of over twenty thousand, the West Virginia University department of mathematics was faced with the challenge of developing a procedure to efficiently place math students into the appropriate math course. It is worth noting that the Schiefele and Csikszentmihalyi (1995) study had not yet been published. Based upon the belief that a student's demonstrated math ability would be an adequate predictor of future success in mathematics courses, and therefore of use for student placement, the West Virginia University Department of Mathematics began to search for adequate assessment tools to determine the mathematical ability of incoming students. In the 1994-1995 academic year, the WVU math faculty conducted an in-house study in which the grades earned by students in undergraduate mathematics courses after admission to WVU were compared to their ACT/SAT scores at the time of their admission. This WVU study tracked thousands of student records of actual results over a one year time period, and supported the findings of Schiefele and Csikszentmihalyi. WVU found that students who scored exceptionally high on the math components of the ACT/SAT tests had an increased probability (alpha of .21) of being successful in pre-calculus courses (by which we mean any college level mathematics course taken prior to calculus). This in-house study found no correlation (a negative alpha) between these standardized test scores and subsequent success in mathematics courses for the lower range of ACT/SAT scores. The study also showed that when the student population was considered as a whole, only a very weak correlation existed between the standardized test scores and student success.

At this time the WVU math department had at its disposal an in house placement exam developed over several years of application. In an attempt to determine the effectiveness of this assessment tool a similar analysis of the WVU in-house Math placement exam (by which the students had been placed into the courses) was conducted. This study showed similar results, with a weak correlation between the test score and subsequent success in pre-calculus courses (alpha .26), but again only at the high end of the scores. Even though the correlation between scores on the in-house placement exam and success in a subsequent course was marginally better than that for the ACT/SAT tests, it still was low enough to indicate that the in-house test was also an inadequate tool for effective placement into the first college level mathematics course taken by a student.

1.2 CURRENT PRACTICES

With the potential need for more than twenty thousand students to be adequately and efficiently placed into a math course and no alternative placement methods available, the decision was made to follow the method of sister institutions and place students into courses based upon their ACT/SAT scores as the primary placement method. While an in-house exam would no longer be used to determine this initial placement, it was decided to continue to use such a test as a supplement to the ACT/SAT scores. As a result, WVU adopted the following placement policies: preliminary placement into mathematics courses is done based on ACT/SAT scores, which are used as cut off points for entrance into particular courses. As an example, an ACT score of 21 or SAT score of 520 or higher is required to enroll in college algebra.

Students who wish to enroll in these courses but who do not meet the prerequisite requirements may challenge this placement by taking an in-house placement exam (this exam can only be taken once in four years, and placement is based on either the ACT/SAT or placement score, depending on which places the student into the higher course). Students who are not able to place into a college algebra course by one or the other of these means may take a developmental course called the Math Workshop (for which students receive no college credit). The Math Workshop is a developmental course designed to provide a review of materials and skills required for college algebra. Students must complete the Workshop, a 13 week course meeting three times per week (for 90 minutes each class period), and must maintain a grade of a C or better in order to be allowed to enter College Algebra (Math 124 or Math 126), a course which is a prerequisite for any higher course (such as Trigonometry, Calculus, etc).

1.3 PROBLEM STATEMENT

During the past ten years West Virginia University math students have demonstrated high failure rates in their mathematics courses, as an example I have included data for Math 128(trig), Math 126 (college algebra) and Math 129 (pre-calculus) for the past 5 years, (see tables 1A-1C below). Of specific concern are these lower level courses which serve the mathematically lower level students. These lower level students constitute over 80% of the 26000 + student population.

TABLE 1A

Math 124 Grade Distribution (Fall 1997-Spring 2002)							
	%A	%B	%C	%D	%F	%W	%DWF
Fall 1997	21.1	19.3	10.5	11.4	18.4	19.3	48.1
Spring 1998	3.3	14.0	21.3	15.3	16.0	30.1	61.4
Fall 1998	27.7	21.9	13.1	9.2	15.0	13.1	37.3
Spring 1999	14.6	14.2	13.4	16.5	17.7	23.6	57.8
Fall 1999	19.2	16.5	16.2	11.7	20.1	16.3	48.0
Spring 2000	13.1	23.1	17.4	11.0	13.4	22.0	46.4
Fall 2000	33.6	22.6	25.4	5.4	7.1	5.8	18.3
Spring2001	31.5	26.2	14.5	10.5	12.5	4.8	27.8
Fall 2001	2.9	29.2	37.8	8.2	7.7	14.2	30.1
Spring 2002	1.3	7.3	32.1	16.7	23.8	18.8	59.3

TABLE 1B

Math 128 Grade Distrubution (Fall 1997- Fall 2001)							
	%A	%B	%C	%D	%F	%W	%DWF
Fall 1997	9.7	20.5	23.7	12.7	17.3	15.9	45.9
Spring 1998	14.4	14.5	23.4	16.2	15.6	15.9	47.7
Fall 1998	16.3	17.2	20.1	12.1	13.6	20.7	46.4
Spring 1999	21.7	23.1	17.7	10.2	15.5	11.8	37.5
Fall 1999	11.4	18.4	18.1	18.4	18.7	15.0	52.1
Spring 2000	11.0	21.2	21.7	16.2	16.8	13.1	46.1
Fall 2000	11.8	16.8	20.4	13.8	18.0	19.2	51.0
Spring 2001	14.2	21.1	22.1	13.9	16.5	12.2	42.6
Fall 2001	7.7	24.1	24.1	9.9	11.8	22.4	44.1
Spring 2002	11.6	23.7	23.7	12.3	11.7	17.0	41.0

TABLE 1C

Math 126 Grade Distrubution (Fall 1997 - Fall 2001)							
	%A	%B	%C	%D	%F	%W	%DWF
Fall 1997	19.4	27.0	21.2	11.6	10.8	10.0	32.4
Spring 1998	17.5	26.7	19.8	12.9	12.7	10.4	36.0
Fall 1998	7.3	16.9	20.4	13.9	19.8	21.7	55.4
Spring 1999	6.2	17.6	22.0	15.1	15.5	23.6	54.2
Fall 1999	8.7	20.0	23.2	14.4	17.7	16.0	48.1
Spring 2000	7.0	20.8	22.6	15.0	16.5	18.1	49.6
Fall 2000	12.5	20.7	19.0	12.8	16.5	18.5	47.8
Spring2001	10.2	19.9	17.9	14.4	17.9	19.7	52.0
Fall 2001	1.0	24.5	18.6	11.4	26.3	18.2	55.9
Spring 2002	9.9	19.8	18.8	16.1	12.3	23.1	51.5

There is an overwhelming need to determine the underlying reasons for these high failure rates. Given the high failure rates two questions immediately arise. First: Are the methods employed to place students adequate? An issue of grave concern among mathematicians at WVU since WVU adopted placement practices which research, both within and without the math department, had shown would apply to only 20% of the student population. Second: Are there variables in play other than prerequisite math knowledge which contribute to the failure rates? These questions need to be better defined and developed into specific hypotheses to provide the springboard to launch this research project.

1.4 HYPOTHESES

It has long been accepted that the nature of mathematics is one of a sequence of concepts, where understanding of one concept or mastery of an algorithm, allows the learner to proceed to more complicated procedures which incorporate the simpler concepts. It must then be true that for a student, preexisting knowledge or ability in math must have some affect upon the learning of new math topics. As shown by Schiefele and Csikszentmihalyi , for the higher pretest scoring mathematics student's there is little doubt that pre-existing knowledge or aptitude in the subject is a significant factor in the students success (or lack of success), One topic not documented within this study but which is readily apparent to those of us who teach in a mathematics department, is that the students who score high on pretests usually take higher level courses. Clearly, for higher level mathematics courses, prerequisites are a critical factor in the students' performance. However, a common hypothesis among mathematics faculty is that, for very low level math courses, it is possible for students to learn the prerequisites while learning the course work, if they put forth an above average effort. While the validity of this hypothesis has not been documented, every math faculty member at WVU can sight instances where students who should have failed due to a lack of prerequisite knowledge, succeeded. Why then do we at WVU have high failure rates?

Seven years of personal experience as a lecturer at WVU suggest some other variables affect math performance. Data from co relational studies also make it clear that variables other than tested aptitude contribute to student success. Some students who score highly on either standardized or customized tests do very well in their math courses, while others, who according to their test scores are expected to do well, fail or drop the class. Still another group, who is expected to not succeed based on their test performance, will succeed. While only anecdotal in nature, there are numerous reports by university faculty of instances of students with very poor preparation for a class who significantly outperform their better prepared peers. In fact, math educators at WVU commonly ascribe this to an observed disparity in the amount of effort put forth by the students, and their associated disparities with respect to the ability to communicate mathematically. These educators have through their grade books documented hundreds of cases where students with mid to high SAT/ACT or placement test scores failed their course, while numerous other students with relatively low scores were successful.

The main hypothesis or assumption for this study is that there exist various factors which influence a student's achievement in mathematics. Further that these factors are not limited to mathematics aptitude but are rather psychological in nature. Also, that the influence of the individual factors are additive in nature and as such need to be looked at in a simultaneous manner for over all affect.

In this same regard I hypothesize that these factors will not influence individuals in a constant manner. Different individuals will be influenced to different degrees dependent on their personal history and make-up. Further, I hypothesize, that there exists a means to categorize students where the members of a certain category are influenced in similar manners by the same factors. Therefore it is further my hypothesis that a contributing factor to the low correlation between attitude and math achievement shown in previous studies is the inclusion of all students into a single group. It is my contention that attitude, effort and motivation are all interrelated, and that the affects of these factors will significantly vary dependent upon the differences of the combination of characteristics within that group of students. These differences in characteristics are also connected to the prerequisite math aptitude the student initially brings to that particular course. Therefore another modification to the hypothesis is not to put all subjects into a single grouping, but rather to look at various subgroups individually. The inclusion of all students into a single group would nullify the effect of individual differences. Once partitioned, the students within each partition will manifest similar characteristics to some degree. The differences in characteristics are best described using a comparison of the amount of effort the subject will need to put forth to be successful.

It is then necessary to review the literature to investigate the possible factors which could influence achievement as well as the manner in which these factors connect to the differences among individuals.

CHAPTER II

2.1 LITERATURE REVIEW

The researchers in many fields of study are beginning to recognize and identify variables which influence both learning and classroom performance. The current literature in many content areas is now emphasizing the importance of factors other than the actual subject content itself. Most sources term these factors, Affect. Recently mathematics education has begun to understand and research the importance of Affect. There is, however one area of study which has thoroughly and extensively researched the aspects of Affect, and that area is, Second Language Learning, sometimes referred to in the literature as Second language Acquisition (SLA). Interestingly enough researchers within second language learning have previously investigated the very topic of this discussion, factors which affect performance within the college classroom.

In the study of affect, as it applies to the college classroom, it is then necessary to look at the current literature in both mathematics education and in second language learning and draw the appropriate comparisons. What follows is a discussion of Affect and is various factors in both Math education and in Second language learning.

2.2.1 AFFECT

Previous math education research has treated affect as an avoidable complication of little significance. In recent years however, math educators have made significant progress in understanding these affective issues. As a result, within math education, much research has been done on the three individual components of the affective domain.

Within mathematics education, Affect is defined by the majority of sources to be made up primarily by beliefs, attitudes and emotions. There are a number of large scale studies which provide substantial data indicating the need for concern regarding Affective factors. The Second International Mathematics Study (Robertaille, 1989) shows that there are substantial differences among countries on measures of mathematical beliefs and attitudes, as there are differences in measured achievement. Dossey, Mullis, Lindquist, and Chambers(1986) report that students in the United States become less positive about mathematics as they proceed through school. While in countries such as Germany, students become more positive regarding mathematics as they progress through school.

The National Council of Teachers of Mathematics puts considerable emphasis on affective issues in its recent issue of Curriculum and Evaluation Standards for School Mathematics, two of the major goals of the standards deal with helping students understand the value of mathematics as well as developing confidence mathematically. In the Standards, it is recommended that teachers assess student confidence, interest, perseverance and curiosity.

Working within this accepted definition of Affect, researchers within math education focus primarily on the three categories or classifications of variables which constitute Affect. These are beliefs, attitudes and emotions. Beliefs, attitudes and emotions are terms that reflect the range of feelings and moods that make up our affective responses to mathematics (Parsons and Adler,1982). These terms vary in the level of intensity of the affect they represent. They also vary in stability (Mandler,1989): Beliefs and attitudes are relatively stable and resistant to change, but emotional responses to mathematics may change rapidly. As an example, students who say they dislike math (an Attitude) are likely to express the same response at a later time. A frustrated student who usually likes math, but who is working on a difficult problem, may utter the same statement (an emotion) which may change once the problem is solved.

Beliefs, attitudes, and emotions also differ in the way in which cognition is applied within the affective response. I do not believe it is not possible to separate student responses into discrete affective and cognitive categories. As an example, beliefs are built up over a fairly long period of time, and as such are mainly cognitive in nature. On the other hand, emotions which can appear quite suddenly have a much more powerful affective component. The terms as they are listed here, beliefs, attitudes, and emotions, are listed in order of increasing affective involvement, decreasing cognitive involvement, and decreasing stability (Grouws, Chambers, 1989).

The field of second language learning in particular has conducted an extensive amount of research on the influence of affect in the learning process which includes all the aspects of affect as defined by mathematics educators listed above. Second language learning has led the way in the study of the influence of Affect. Stern's claim that "the affective component contributes at least as much and often more to language learning than the cognitive skills (1983), is supported by a large body of recent cross-disciplinary research showing that affective variables have significant influence on language achievement (e.g. Gardner 1985; Skehan 1989; Spolsky 1989; Gardner & MacIntyre 1992; 1993). The study of affect has thus become increasingly popular in the

1980s and 1990s, J. H. Schumann (1975) offers an excellent review of early literature on affective factors and the problem of age in SLA(second language acquisition) research, and Arnold & Brown (1999) provide a more contemporary perspective from the view of the language learner as an individual (anxiety, inhibition, extroversion/introversion, self-esteem, motivation [extrinsic/intrinsic], learner styles) and as a participant in a socio-cultural situation (empathy, classroom transactions, cross-cultural processes).

Arnold (Ed. 1999) defines affect in terms of "aspects of emotion, feeling, mood or attitude which condition behavior", while Dickinson (1987) describes it as being concerned with the learner's attitude towards the target language and users of it, and with his/her emotional responses. Stevick (1999) follows Dulay et al.(1982):one's 'affect' towards a particular thing or action or situation or experience is how that thing or that action or that situation or that experience fits in with one's needs or purposes, and its resulting effect on one's emotions ... affect is a term that refers to the purposive and emotional sides of a person's reactions to what is going on. (Stevick 1999). This review of affect in second language learning follows and extends Stern's (1983) three major concepts of affect (attitudes, motivation and personality), to include beliefs, anxiety, learning styles (personality) and the learning environment.

2.2.2 BELIEFS

Within Mathematics education research on beliefs has been performed in three general areas, beliefs about mathematics, beliefs about the self, and beliefs and the social context. Research on student beliefs about math has received much attention in recent years. Data from the National Assessment of Educational Progress (Brown 1988) indicate that these beliefs about mathematics, although not emotional in themselves, tend to generate more intense emotional reactions. Studies in problem solving, Schoenfeld (1985), has demonstrated that some beliefs about mathematics limit a students ability to solve non-routine problems. He found that many students hold the belief that only geniuses can do math. Interestingly he postulates that the traditional curriculum supports the development of such beliefs.

Much of the research on affective factors in mathematics education tends to focus on beliefs about the self. One area of beliefs that has been researched extensively is gender differences. Most of the data for these studies have come from the Fennema/Sherman scales, especially the scale on perceived usefulness of mathematics. Fennema (1989) notes that males in general rate the usefulness of mathematics higher than females. Another area of research which is only beginning to be researched is in the factors of student confidence. Reyes(1984) and Meyer and Fennema (1988))summarize the relevant literature regarding confidence. In general males tend to be more confident than females even when the females have exhibited superior performance in the past.

Another set of self beliefs that has been investigated extensively is the area of casual attributions; the reasons students give for their success and failures. Weiner (1986) presents the three central themes to this area. These themes are Locus (internal or external), stability (ability vs. effort) and controllability of the cause of success or failure. These sets of beliefs develop into a pattern of motivational behavior (Holmes, 1990). According to Holmes, motivation/effort is a direct result to the learners self beliefs. A related field of study is learned helplessness. Diener and Dweck (1978) describe learned helplessness as a pattern of behavior where students attribute failure to a lack of ability. Such students demonstrate a low level of persistence and attempt to avoid mathematical challenges whenever possible, again this is tied to motivation and effort.

Recent research in math learning has given attention to the social context of the math classroom. Grouws and Cramer (1989) found that the more effective math teachers were characterized by a supportive classroom environment where students were encouraged to be enthusiastic and enjoy mathematics. Similarly, Parsons, Adler, and Kaczala (1982) found that students react to social norms provided by their parents. The final observation is that it becomes clear that social settings and culture promote certain beliefs about education in general and mathematics in particular, and that these beliefs have a powerful influence in students affective responses to mathematics. The Parsons, Adler, and Kaczala study(1982), found that effort and motivation is directly tied to the social norms provided by their parents.

Major research on language learning beliefs was carried out by Horwitz (1981; 1985), who developed the "Beliefs About Language Learning Inventory" to assess teacher and student opinions on a variety of issues related to language learning (1985). This was used in three quite large-scale American studies (Horwitz 1988; Kern 1995; Mantle-Bromley 1995), with similar results, learner/teacher beliefs differing on only a few items: i) learners underestimated the difficulty of language learning; ii) they held misconceptions about how to learn foreign languages; and iii) they gave more value to accent than teachers did. Horwitz proposes that gaps between teacher and learner beliefs probably result in "negative [language-learning] outcomes" (1988:292), and others have given theoretical support to this idea (Politzer & McGroarty 1985:118; Oxford & Nyikos 1989; Cotterall 1995; 1999; Green & Oxford 1995; Mantle-Bromley 1995; Littlewood *et al.* 1996). Kern concluded that learner beliefs are "quite well entrenched" (1995) and do not automatically change when learners are merely exposed to new methods, while Mantle-Bromley (1995) found that learners with realistic and informed beliefs are more likely to behave productively in class, work harder outside class, and persist longer with study (1995).

Horwitz's, Kern's and Mantle-Bromley's suggestions that incorrect beliefs are detrimental to language learning: "[a] statistically significant association was found between learner beliefs and proficiency" (Peacock 1998). Thus (for example) the 64% of learners (compared with 7% of teachers) who believed that "Learning a language is mostly a matter of learning a lot of grammar rules", were significantly less proficient than the other 36% who had a different view of the nature of language learning. It remains to be seen to what extent this lack of proficiency was caused by mistaken beliefs, or by frustration and dissatisfaction resulting from holding beliefs different from those of the teacher (Peacock 1998), and further, whether changing such beliefs results in increased proficiency (an assumption behind much of the work on metacognition). Oxford (1999) and Young (1991) draw a link between unrealistic learner/teacher beliefs and language anxiety, and Peacock describes how mistaken beliefs can result in a lack of student confidence, through lack of success being attributed to lack of aptitude (71% of Peacock's students believed in the existence of foreign language aptitude, though only 14% believed they had that aptitude - Peacock 1998).

2.2.3 MOTIVATION

Most researchers and educators would agree that motivation "is a very important, if not the most important factor in language learning" (Van Lier 1996), without which even 'gifted' individuals cannot accomplish long-term goals, whatever the curricula and whoever the teacher. Thus the concept of language learning motivation has become central to a number of theories of second language acquisition (e.g. Clément 1980; Krashen 1981; Gardner 1985; Spolsky 1985), and motivation has been widely accepted by teachers and researchers as one of the key factors influencing the rate and success of second/foreign language learning (cf. Gardner 1985; Ely 1986a; 1986b; Dörnyei 1994; 1998: Scarcella & Oxford 1992; Tremblay & Gardner 1995; Oxford & Shearin 1996; Williams & Burden, 1997), often compensating for deficiencies in language aptitude and learning (Tremblay & Gardner 1995). It could be said that all other factors involved in second language acquisition presuppose motivation to some extent.

In the field of second language learning, Gardner & Lambert (1959) pioneered work on motivation, proposing an integrative-instrumental duality (Gardner et al. 1976), which became widely accepted and confirmed by a number of studies (cf. Gardner 1985 for a review). Their ten-year-long research program (1972) in which they found that success in language attainment was dependent on the learner's affective reactions toward the target linguistic-cultural group (in addition to aptitude) gave validity to the study of motivation in SLA.

Gardner & Smythe's (1975) original model of motivation (cf. Stern 1983) contains four main components : i) group-specific attitudes; ii) learners' motives for learning the target language; iii) affective factors (Stern's 'Generalized Attitudes'); and iv) extrinsic and intrinsic motivation (Stern's "Attitudes towards the learning situation"):

This model was subsequently expanded in Gardner's (1985) socio-educational model of the ways in which motivation for foreign language learning operates in educational settings (Au 1988; Gardner 1988), and has been summarized in terms of five hypotheses:

1. The integrative motive hypothesis: Integrative motivation is positively associated with second language achievement.

2. The cultural belief hypothesis: Cultural beliefs influence the development of the integrative motive and the degree to which integrativeness and achievement are related.

3. The active learner hypothesis: integratively motivated learners are successful because they are active learners.

4. The causality hypothesis: Integrative motivation is a cause; second language achievement, the effect.

5. The two process hypothesis: Aptitude and integrative motivation are independent factors in second language learning.

As seen in the preceding discussion, motivation is a crucial affective factor in second language learning. In math education motivation and effort have not been as extensively researched as in second language learning, but are just as important. Within mathematics education motivation and the accompanying beliefs are associated with the learners concept of self (Holmes, 1990) and as such are listed within the affective factor of beliefs, including the area of casual attributions. In second language learning this corresponds to Gardner's cultural belief hypothesis: Cultural beliefs influence the development of the integrative motive. This corresponds to the discussion of beliefs in the social context , Parsons, Adler, and Kaczala (1982).

In a 1996 study, Pintrich & Schunk found that motivation has significant influence upon the learning of new material as well as performance using previously learned skills. In support of this is a 1995 study in which Schiefele and Csikszentmihalyi found that interest in mathematics is an intrinsic motivational force and that it is directly correlated to student success in secondary school.

2.2.4 ANXIETY

In mathematics education, feelings and moods like anxiety, confidence, frustration and satisfaction are all used to describe responses to mathematical tasks. Therefore, within math education, anxiety is considered an aspect of attitude. Math anxiety has been a focus of research for many years and has perhaps received more attention than any other area that lies within the affective domain.(Reyes, 1984). Within math education the concepts underlying the research continue to be murky and the terminology unclear. Hart (1989), in an attempt to clarify the terminology found that in some math education literature, anxiety is defined as fear, which is a "hot" emotion and in still other literature dislike, which is an an attitude. Throughout the literature math anxiety is used as either an emotion or an attitude seemingly at the particulars authors whim. To further complicate the issue, conceptions of math anxiety seem to overlap with test anxiety and the proposed solutions seem to be the same for both(Sarason,1987). Regardless, math anxiety is a major obstacle for many students. Bertz (1978) found that a significant number of mathematics students experience apprehension with regard to their math abilities, further she found that at least one fourth of college students experience math anxiety. She contends that math anxiety most probably stems from the individuals history of performance and other affective factors in the learning of math. Math anxiety thus represents a major stumbling block, not only in mathematics courses, but also in and any course which requires the use of mathematics (such as statistics, physics, chemistry, accounting, and many others). Adams and Halcomb (1986) found a relationship between math anxiety and performance, and contend anxiety is a good predictor for math acheivement.

Within second language learning the use of anxiety is consistent through out the literature. In this area research has confirmed the existence of 'language anxiety' and its effect on second language learning (MacIntyre & Gardner 1991), pointing to a reciprocity between anxiety and proficiency (MacIntyre *et al.* 1997), such that "even in optimum conditions, students can experience destructive forms of anxiety" (Reid 1999). However, this effect is complex and difficult to measure (Phillips 1992), though research (and the experience of teachers) suggests that language learning contexts are especially prone to anxiety arousal (Horwitz *et al.* 1986; MacIntyre & Gardner 1989; 1991; Price 1991; MacIntyre 1995), with Campbell & Ortiz (1991) estimating that up to half of all language students experience debilitating levels of language anxiety, and Horwitz (Horwitz *et al.* 1986) finding that language anxiety can cause students to postpone language study indefinitely or to change majors. Because of this, language anxiety has been the subject of a good deal of research, on the assumption that an understanding of its causes and investigation into how to reduce language anxiety will improve learner performance and increase learning satisfaction by easing tensions and reducing demands on cognitive processing space (Eysenck 1979). Scovel (1978) provides an early review of anxiety research, which is supplemented by the excellent reviews of MacIntyre & Gardner (1991b), and Gardner & MacIntyre (1993a). Consideration of psychological aspects of learning is important in the study of anxiety, as can be seen in Scovel's reference to an emotional state of "apprehension, a vague fear that is only indirectly associated with an object" (1978), and in Horwitz *et al*'s (1986) "subjective feeling of tension, apprehension, nervousness, and worry associated with an arousal of the autonomic nervous system." Such psychological definitions most commonly refer to a "transitory emotional state or condition characterised by feelings of tension and apprehension and heightened autonomic nervous system activity" (Spielberger 1972), a state which can have both negative and positive effects, and which motivates and facilitates as well as disrupting and inhibiting cognitive actions such as learning.

Cognitive and affective components of anxiety were identified by Liebert and Morris (1967) as "worry" and "emotionality", the former being defined by Sarason (1986) as "distressing preoccupations and concerns about impending events" (1986), often taking the form of distraction, self-related cognition such as excessive self-evaluation, worry over potential failure, and concern over the opinions of others (Eysenck 1979). Such outcomes often impair task performance, which has itself been the subject of much research into language anxiety (often to the exclusion of the cognitive activity preceding that performance [Eysenck 1979]), results of which suggest that anxiety causes cognitive interference in performing specific tasks (cf. Schwarzer 1986). Horwitz *et al.* (1986) draw attention to three related performance anxieties: i) communication apprehension; ii) test anxiety; and iii) fear of negative evaluation, and Eysenck (1979) offers a *reconceptualization* of anxiety in terms of this interference, suggesting that the anxious person has his/her attention divided between task-related cognition and self-related cognition:worry and other task-irrelevant cognitive activities associated with anxiety always impair the quality of performance. The major reason for this is that the task-irrelevant information ... competes with task-relevant information for space in the processing system. (Eysenck 1979)

Mantle-Bromley (1995) observes that "without a positive learning atmosphere, students may well gain little or nothing from new curricular infusions". Indeed, whatever the curriculum, the teaching methodology, the textbook, or other institutional factors, the "business of learning" (Fraser 1986) is typically carried out in classrooms, Recent qualitative reports suggest that anxiety *matters* to students of all abilities (Bailey 1983; Horwitz *et al.* 1986; Price 1991), especially when there is heavy ego-involvement (Bailey 1983; Horwitz *et al.* 1986; Price 1991; Young 1990), as in oral examinations (Tobias 1980). Horwitz & Sadow (Horwitz & Sadow, submitted) indicate that high language anxiety is related to students' "negative concepts of themselves as language learners, and negative expectations for language learning", begging the question of whether language anxiety is a cause of reduced achievement, a result, or both.

Ely (1986a) suggests an inverse relationship between "language class discomfort" and personality traits such as risk-taking and sociability, and Sano *et al.*

(1984) claim that creative production is possible only in a "non-threatening environment" which encourages meaningful learning and the creative use of English. They see learning as dependent on:

> ... warm-hearted interaction between teachers and learners, as well as among learners themselves. This friendly interaction is, in our opinion, the most essential factor in successful language learning. (Sano *et al* 1984)

2.2.5 ATTITUDE

Research on attitudes toward mathematics has a long history. The majority of the early research includes beliefs as part of attitude. Reviews of the most recent research and the accompanying analysis has been provided by Kulm, Leder, and Reyes. The majority of the reported research looks at specific components of attitude and many times include beliefs as attitudes.

Webster's Revised Unabridged Dictionary (1913) defines "attitude" as "a complex mental orientation involving beliefs and feelings and values and dispositions to act in certain ways", while Collins Cobuild Student's Dictionary explains that: "Your attitude to something is the way you think and feel about it". Psychological theories on attitudes refer to an evaluative, emotional reaction (i.e. the degree of like or dislike associated with the attitudinal object) comprising three components: *affect, cognition*, and *behaviour* (Rajecki 1990; Zimbardo & Lieppe 1991), these components undergoing change when there is "dissonance" or disagreement between them (Rajecki 1990; Zimbardo & Lieppe 1991; Eiser 1994; Mantle-Bromley 1995:373).

A 1998 study by Cooper, Harris, Lindsay, Nye and Greathouse, provides another connection between attitude and performance. This study established a positive correlation between a students attitude and homework behavior. This study also demonstrated a positive correlation between homework behavior and success in the math classroom, especially in higher level mathematics courses. Again the correlations (alpha) were small but significant

For this study I will distinguish attitude as the positive or negative affective responses that are relatively stable. This will include the following variables from all three categories of affect: a)Math anxiety b) Self confidence c) Previous experiences in the mathematics classroom d) Their perceived self image of their ability e) The students belief system about how math is learned f) The reason the student is studying math g) Comfort level in the classroom h) The attitude they perceive from the instructor.

A logical extension to the research on the variables of Affect is to investigate their influence on learning and achievement. There has been an extensive amount of research done in the area of attitude and its influence upon achievement. However the majority of this research has attempted to correlate specific attitudinal variables with achievement. Within the field of math education there have been some notable studies. A 1980 study by Elmore and Vasu attempted to clarify this topic within math education. These researchers compiled over 20 different studies on the connection between attitude and achievement. The correlations on attitude and achievement reported in these reports ranged from a low of .09 to a high of .36. Many other studies are available, such as; (Dossey and Mullis, 1988, Kulm, 1980, Leder, 1987, Reyes, 1984, adams and Halcomb, 1986) all report similar results, they report a small but significant correlation between attitude and achievement within the math classroom.

Early research on the relationship between attitudes and second language achievement was carried out by Gardner and Lambert in the 1950s, and later by Schumann (1975), who found a number of contributory factors: i) *language shock* (resulting in feelings of dissatisfaction, frustration or guilt); ii) *culture shock* (producing feelings of alienation or anxiety and rejection of native speaker values); iii) *language stress* (shame and loss of self-esteem resulting from a perceived deficiency in language); and iv) *anxiety* (due to the infantile persona necessarily projected by the language learner). Sauvignon (1976) points out that teachers also have attitudes and beliefs about language learning, and that these affect their teaching:

2.2.6 EMOTIONS

One of the early studies by Bloom and Broder (1950) on problem solving noted that students experienced periods of tension and frustration. However reports of strong emotional responses to mathematics do not appear in the literature very often. Wagner, Rachlin and Jensen (1984) report that algebra students often get upset and grope wildly for any response however how irrational the response may be. Brown and Walters report that making conjectures about math can be a great joy to students. Although comments about emotion do appear in the research literature it is unusual t for research in math education to include measures of affect that accompany emotions.

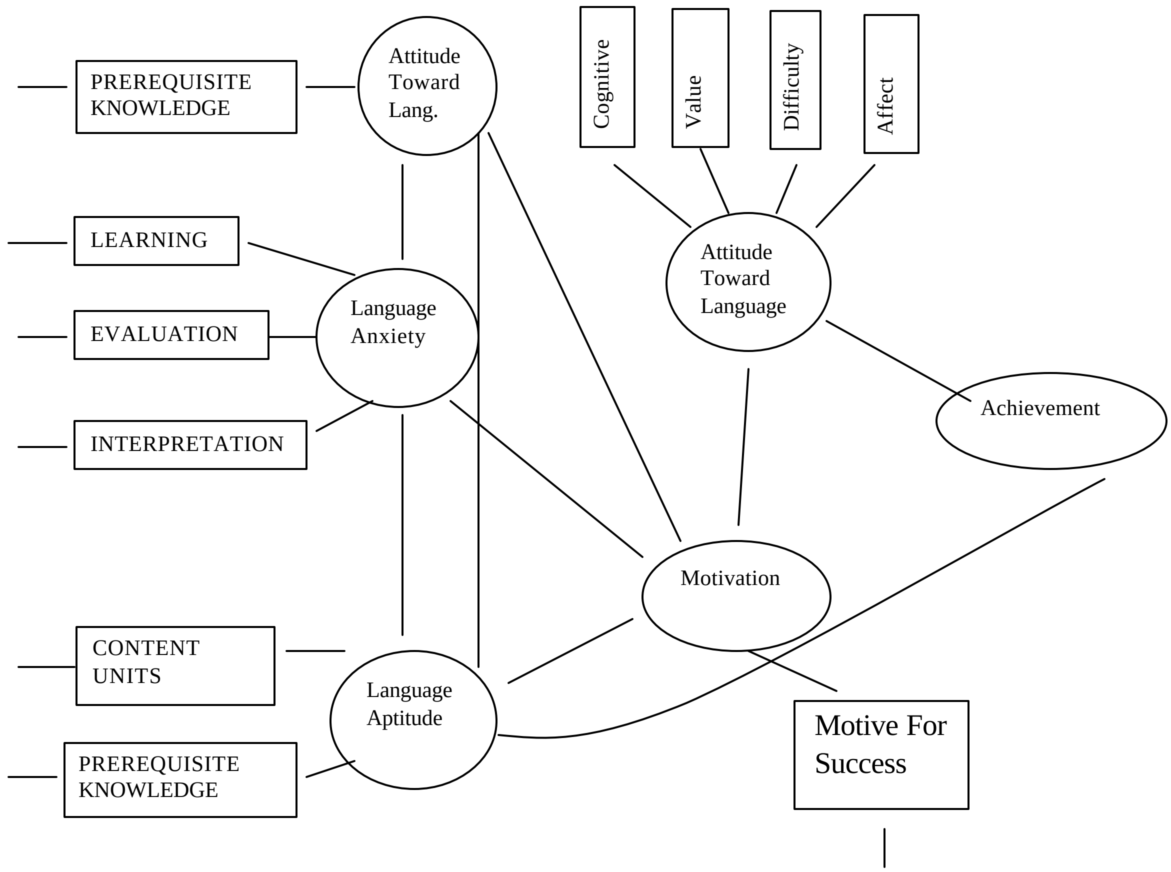
2.2.6 SUMMARY OF THE AFFECTIVE DOMAIN

In math education we look at Affect as (beliefs, attitude and emotion) and in second language learning one looks at affect as (attitudes, motivation, personality (beliefs, anxiety, learning styles) and the learning environment). Second language learning and math education use the same schema to outline affect. Both use the larger concepts of affect as factors and break the factors up into individual variables. The components of both the math education approach to affect and the second language approach to affect are remarkably similar, in fact on a theoretical basis the two compare affect variable to affect variable, they do however vary in how each variable is categorized. Both second language learning and mathematics education consider attitudes in a similar manner as distinct factors of Affect. Second language deals with beliefs and anxiety as variables which are part of personality, Math education deals with beliefs as a separate factor and anxiety as a variable within emotions. Second language deals with emotions as a variable under personality, and math ed. deals with emotions as a separate factor. Within second language learning motivation is a separate factor, while math ed. deals with effort and motivation as variables under the factor beliefs.

To summarize, there is a marked similarity between the variables of affect as researched within second language learning and mathematics education. The research on beliefs, anxiety, social context, emotions and many aspects of motivation are for the most part in agreement, the differences being that second language learning is leading math education. Within the field of second language learning there has been numerous studies, comparing the relationships between individual differences in cognition and affect (e.g., feelings, moods, attitudes, anxiety, and motivation), with student achievement. Math education has studied these individual differences but has not as yet made the connection to achievement in any significant way. Research within second language learning (Trembley and Gardner 1995 ; Gardner & MacIntyre,1991 ; Trembley, Goldberg, &Gardner,1995 ; Kraemer,1993), has shown that individual differences among students are linked to outcome and achievement (success). These individual differences can be grouped into two categories, cognitive and attitudinal. Within each of these categories are variables which are dependent upon the individual. The cognitive variables would include: perceptions, judgments, and subject aptitude. The attitudinal variables would be primarily aspects of attitude (e.g. Feelings, moods, anxiety and motivation). From this research came Gardner's socio-educational model of second language learning.

2.2 CONNECTIONS BETWEEN LANGUAGE, MATHEMATICS, AND ACHEIVEMENT

Gardner's socio-educational model of second language learning has proven itself to be a reliable predictor of student achievement. This model has been the basis for the majority of studies I have investigated concerning attitude and achievement across many subject areas. While motivation is a complex topic within itself, this study will use motivation as defined by Gardner's model. Gardner's model for second language learning defines motivation as an aggregate of effort, desire to learn, and attitude toward learning the subject. A diagram of Gardner's socio-educational model for second language learning is provided in figure 1 below.



FUGURE # 1
SECOND LANGUAGE LEARNING MODEL

As this model is applied to various content areas it is necessary to establish a link between learning a second language, where this model has proven itself, and any new area of study. To make this connection between language learning and mathematics we can first note the both deal with Affect in the same manner, they use the same components to affect but view the components arrangement differently. Current literature supports this as we look at comparisons of variable to variable. One example would be that both mathematics and language deal with anxiety, motivation /effort, belief structures and attitudes. Personal experiences as a lecturer at WVU suggests, that communication within the mathematics classroom, particularly terminology is one of the important factors in student achievement. Several publications have addressed just this issue, works such as, " From Words to Equations, Hinsley, Hayes,& Simon, 1977, "Writing to Learn Algebra", England, Miller, 1989. Within the past decade, states such as Massachusetts, New York and West Virginia have identified writing across the mathematics curriculum as a major objective of the learning of Mathematics within the public school system. Behind this movement is the assertion that there exists a language component within the field of mathematics. A 1993 study by Lalonde and Gardner established a link between the methodology applied in second language learning and learning introductory college statistics. This study by Lalonde and Gardner showed that a second language model, particularly Gardner's socio-educational model of second language learning, was applicable to learning introductory college statistics. In this study they proposed that the learning of statistics is not unlike learning a new language in that both subject areas involve new vocabulary which is foreign to the student. They adapted Gardner's socio-educational model of second language learning and assessed the mathematical background, statistical anxiety, motivational intensity and a number of attitudes in an introductory statistics course. Figure 2 diagrams the modified language model as it was applied to introductory college statistics.

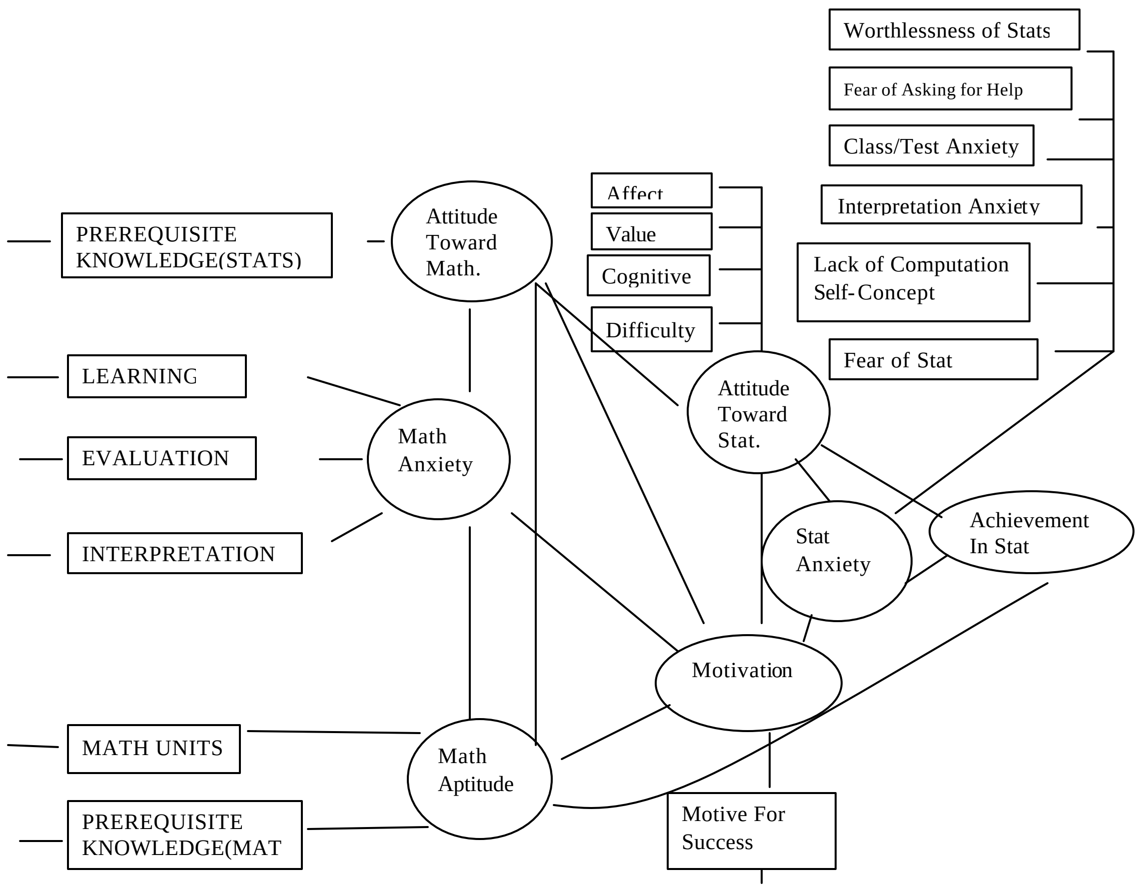


FIGURE 2 : SECOND LANGUAGE LEARNING MODEL APPLIED TO STATS

This application of Gardner's socio-educational model of second language learning has shown that (Lalonde and Gardner 1993) mathematical ability, motivation and attitude are directly related to success in the college level statistics classroom. This study demonstrated that effort and aptitude are the two most significant factors in a student's success. This 1993 study found a direct correlation between the student's attitude toward the study of statistics, the course, the professor and the student's success in that course. In introductory statistics classes there is a connection between motivation, effort, and achievement. When looking at proven teaching techniques in math and allowing for the individual difference among students, it becomes clear that for most students, the learning of mathematics is closely related to learning a second language. Most obvious is the learning of vocabulary and its application in both statistics and math as compared to learning a second language. Clearly, it is a small jump to associate the learning of statistics, where a link between attitude and achievement has previously been established, with the learning of undergraduate mathematics. Gardner's model has been applied to many subject areas but not mathematics directly, this study will apply a version of Gardner's model directly to mathematics.

Those studies which have established a strong relationship between attitude and classroom success have been outside of the field of math education. One reason for this is that math is a core subject area and as such, all students have a history of interactions within the context of math and a math classroom, which complicates the study of attitude and the associated motivation influences. Previous studies within math education, regardless of the methods employed, have found positive but weak correlations between attitude and success. Most research within mathematics education has focused upon specific difference variables singly, such as subject aptitude, anxiety, motivation and other specific aspects of attitude without looking at the combined overall influence these factors have upon student outcomes. Within mathematics there is a lack of research to determine the relations between the individual student differences as a whole and student success. Another weakness with past research is that there has been and underlying assumption that attitude will have the same influence upon students from differing back grounds and levels of math aptitude. This cannot be assumed as at the time of this study there are no documented studies supporting this.

The second language learning model takes into account many of the factors studied in the previous research within math education. There is a need to build upon previous work in statistics by Lalonde and Gardner, and investigate the relationship between the individual differences as related to the various aspects of attitude and student success in mathematics classes using a modified second language learning model. Further the assumption that attitude has an equal or similar level of impact on all levels of students must be discarded. Based upon findings of previous research there is a need to study various groupings of students, grouped by demonstrated aptitude and look at relationships between success, attitude and the groupings.

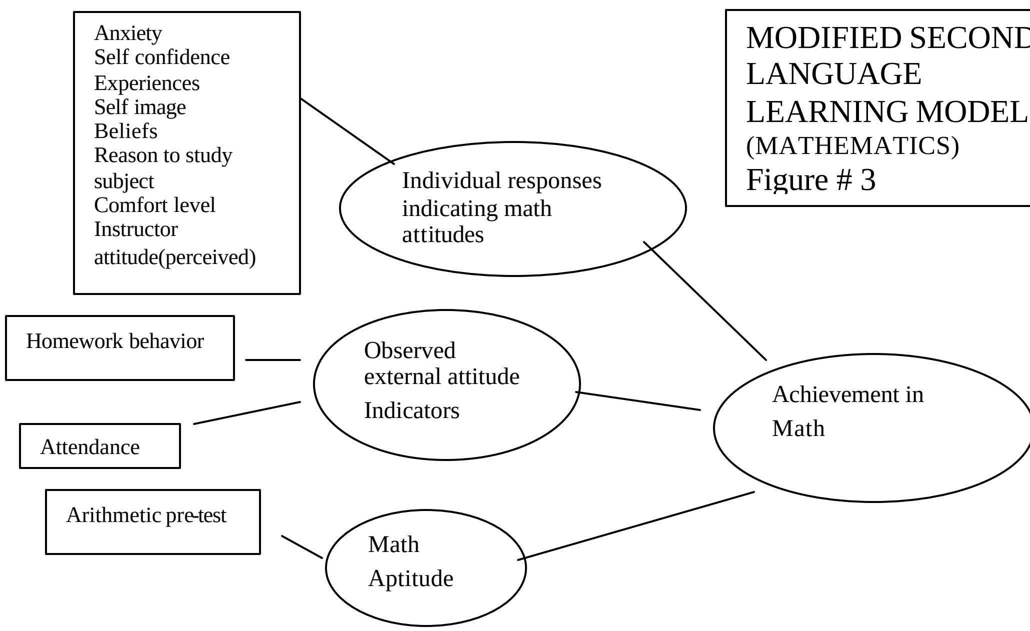
It is then necessary to look deeper into the Gardner and Lalonde model and make any necessary modifications for the particular application to mathematics at WVU, while keeping within the proven theoretical framework of their past success.

2.3 MODIFICATION OF THE SOCIO-EDUCATIONAL MODEL OF SECOND LANGUAGE LEARNING RATIONALE

There are many theoretical models dealing with educational achievement that provide general frameworks that can be applied to various educational subjects, including mathematics and statistics (e.g., Bloom, 1976, Bruner, 1966, Carroll, 1963; Glaser, 1976). All of the variables of affect deemed important by researchers within math education are part of a more specialized socio-educational model developed by Gardner (1979, 1981, 1985) in the area of second language learning. Gardner's model will be used as a basis to study mathematics for two reasons. First, I believe that the conceptualization of mathematics learning as language learning is both meaningful and fruitful. Further, the measures developed by Gardner and others within second language learning (Clement, Smythe and Smythe, 1979) can be adapted to the mathematics learning situation with some modifications, resulting in a usable model for testing during this study.

In the second language learning model twelve measured variables were used as indicators of five latent variables. The hypothesized relationships among these latent variables comprise the structural or theoretical model to be tested (see figure 1). In the model as applied to statistics, figure 2, one of the five latent variables was treated as exogenous (mathematical aptitude) and the remaining four were treated as endogenous (situational anxiety, attitude-motivation index, effort, and achievement). The second language statistics model hypothesized that mathematical aptitude would be a direct positive cause of achievement and a negative cause of situational anxiety, which in turn would be a cause of both the attitude- motivation index and achievement. Moreover, the attitude-motivation index was predicted to be a determinant of effort, and effort was predicted to lead to achievement.

In this study, the second language learning model was modified to utilize, ten measured individual difference variables (Math anxiety, Self confidence, Previous experiences in the mathematics classroom, perceived self image of their ability, The students belief system, The reason the student is studying math, Comfort level in the classroom, The attitude they perceive from the instructor, aptitude, and homework/attendance behavior) were used as indicators of the three latent variables (math aptitude, attitude, effort/motivation). The hypothesized relationship between the latent variables comprises the structural or theoretical model. It was hypothesized, based upon the WVU in house study that the latent variable, mathematical aptitude (our arithmetic test), would not be positively correlated with achievement, except for the upper levels of performance. Moreover the measured homework behavior variable and the measured attendance variable were predicted to be a determinant of effort and effort was expected to lead to achievement. The remaining individual difference variables listed above were predicted to be a determinant of an overall measure of attitude. Attitude in turn is predicted to lead to effort which in turn leads to achievement.



MODIFIED SECOND LANGUAGE LEARNING MODEL (MATHEMATICS)
Figure # 3

There are two basic hypothetical differences between the statistical model and my mathematical model. First, Lalonde and Gardner hypothesized that math aptitude would be directly correlated to achievement, in the mathematics model I am predicting that this will only hold true for the students at the upper levels of aptitude and not hold true for the middle and bottom students. Another difference is that the second language model assumes anxiety and aptitude are independent of one another while the statistical model assumes a negative correlation between aptitude and anxiety. This mathematics model hypothesizes that the correlations with aptitude will vary within the main group, with some subgroups showing negative correlations, some showing positive correlations and some being totally independent of each other.

The methods by which the individual difference variables are measured will be referred to , for convenience sake, as the *measurement model* but in actuality is not an independent model. The measurement model links the measured or indicator variables to the latent variables. The statistical model assessed mathematical aptitude by the measures of mathematical achievement (MACH) and mathematical history (MHIST), while situational anxiety was assessed by the measures of statistics anxiety (STANX) and number anxiety by (NANX). The attitude-motivation index was represented by four variables, attitude toward statistics (ATST), statistics course evaluation (COUR), attitude toward learning statistics (ALST), and motivation (MOT). Effort was assessed by one measure, assignments (ASS). The final construct of achievement was seen to be assessed by three variables, two exam scores and quizzes. Correlations were calculated between each of the variables and achievement, as was an over all correlation calculated by statistical means I choose not to go into here.

The mathematical model in this study utilizes the same basic theoretical framework but with three important differences. First the mathematical model uses different assessment tools for its different variables along with two separate assessment methods, one being measurable assessment tools and the other being a qualitative interview process. The structure is such that correlations are not run between separate difference variables but rather as an over all rating of attitude. The break down is as follows. The course which we are studying is of a much lower level mathematically than college statistics, therefore the math aptitude is assessed through a seventh grade arithmetic test consisting of 100 basic questions. The latent variable, effort, is assessed through homework behavior and attendance calculated as how many assignments were attempted and completed(not the grade of the assignments) and the total attended class sessions. The assessment of attitude required the construction of a survey vehicle and subsequent pilot studies to prove its reliability. The survey instrument measured all the other listed variables producing a reference number indicating a rating for reference purposes of the subjects total attitude score. Correlations were then run for the reference attitude rating and the achievement rating. Achievement was determined by the total score earned by the student on four in class exams, thus isolating the measure of student understanding from effort.

To summarize, the second language learning model demonstrates that the most significant characteristics of the successful student are: study habits, work ethic, and previously mastered prerequisite skills. The modified version will also take these factors into account, but in a much simplified manner. The model for this study will look at various groupings of students to determine a general trend in attitude (good vs. bad) by utilizing the observable indicators of attitude in combination with the subjects self image and opinions about math and the math classroom. Once a general trend in attitude is determined for each student, there achievement in math class with all its various components will be monitored and the two compared to determine relationships between attitude and achievement. Figure 3 above is the diagram of this studies model.

2.4 LIMITATIONS DEFINITIONS AND ASSUMPTIONS FOR THIS STUDY

Crucial to this study is the determination of success and its components. For the purpose of this study I do not wish to attempt to measure learning alone, but rather success as defined within the context of the course being studied. There are many factors which control a student's grade, which in turn is how educators determine success. In courses where homework and individual assignments are required, the student needs to be sufficiently motivated to perform the required tasks and assignments in order to: first, earn points toward their final grade, and second, to master the required skills needed to be successful in the course. This study will not measure the student's level of motivation but will monitor the external indicators of motivation as defined by Gardner in the second language model. These external indicators of motivation are also a portion of the measurement of success in this course(homework and worksheets are part of the grade). The process by which the student completes assigned homework or worksheets, will hereafter be referred to as homework behavior.

Homework behavior will then be used as an indicator of the effort a student is putting forth, which in turn is part of the overall attitude the student demonstrates. A 1996 study by Cooper, Lindsay, Nye, and Greathouse demonstrated that in higher level mathematics courses, homework plays a distinctive role in student achievement. In this study they demonstrated a positive correlation between homework behavior and achievement in math classes. It was shown that, as the complexity of the subject increases, more homework resulted in better grades. I contend that there is a direct connection between homework behavior and attitude/effort. It is expected that those students who have a negative attitude will be less likely to complete the required assignments. In this study I will utilize the individual student's homework behavior as an indicator of attitude and effort. Homework behavior is particularly important for members of the target group, as they posses the potential to succeed along with the risk of failure if they are not sufficiently motivated in the classroom.

When looking for a means to assess attitudes it is necessary to consider attitude in two distinct ways. First is the attitude towards the subject matter which a student has internalized. The internalized attitudes are often kept hidden and are not easily discernable. There are several documented factors which contribute to internalized attitude. These are referred to as individual difference variables. For this study I have particularly emphasized those that apply to mathematics. Factors which will affect student math attitudes are;

a)Math anxiety

b) Self confidence

c) Previous experiences in the mathematics classroom

d) Their perceived self image of their ability

e) The student's belief system about how math is learned

f) The reason the student is studying math

g) Comfort level in the classroom

h) The attitude they perceive from the INSTRUCTOR

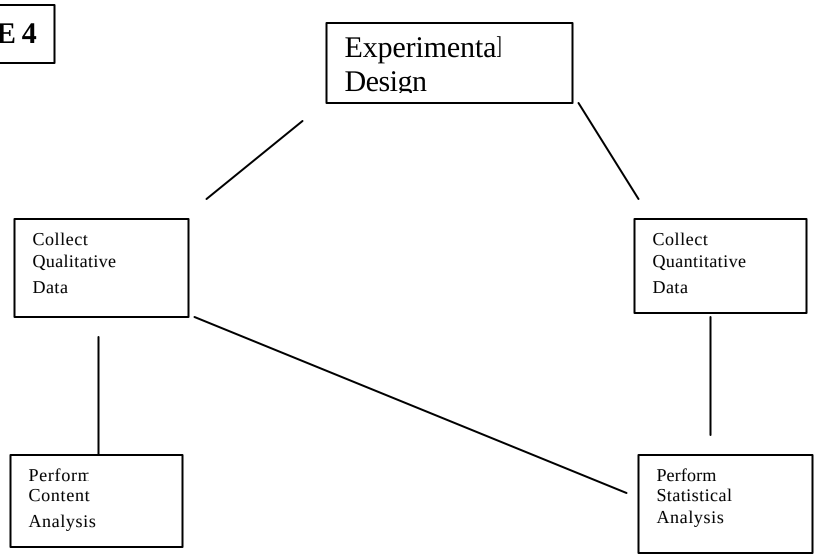
Another way to look at attitude is through indicators or external signs of these internal attitudes. External signs of attitude would include study habits, course attendance, interest in the subject, behavior during class time, and completion of required individual assignments.

CHAPTER III.

3.1 NEW MODEL METHODOLOGY

Research in the study of attitude has shown that a study design in which mixed methods are used, a combination of quantitative and qualitative methods, adds validity to the study. In the text "Qualitative Evaluation and Research Methods, Michael Quinn Patton ", suggests the mixed paradigm design in figure 4.

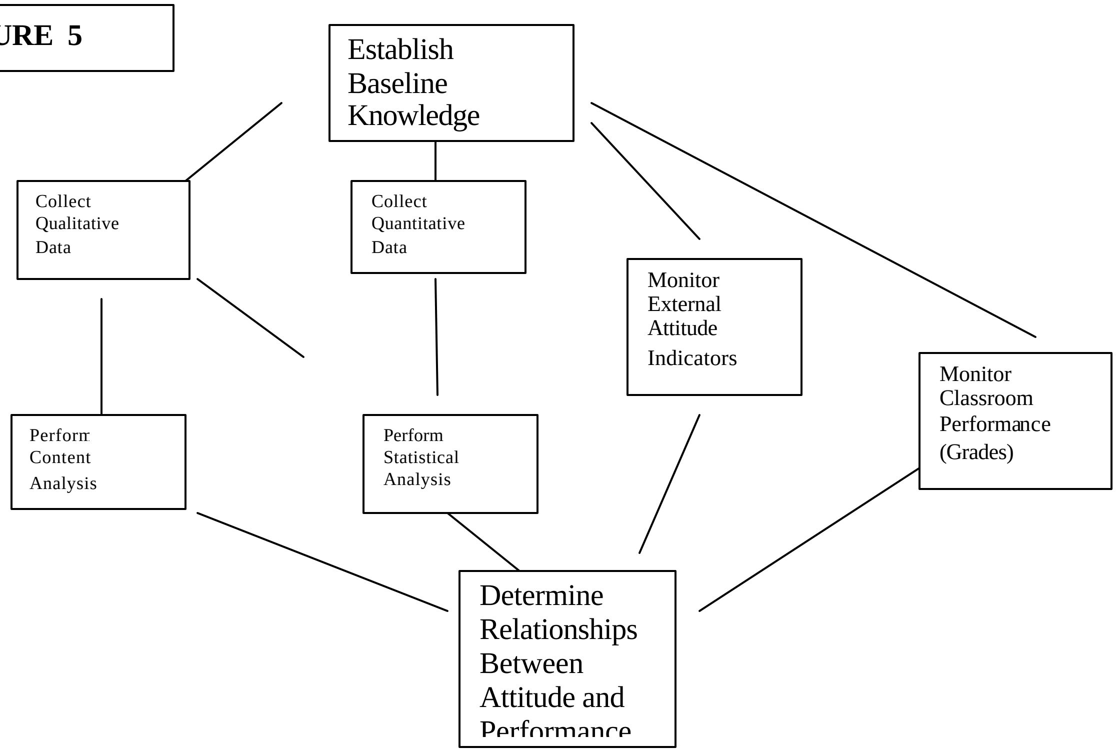
FIGURE 4



As previously stated there are two parts of attitude to be looked at for this study, internalized attitudes about math and the external indicators of the internalized attitudes. In keeping with established practices and to ensure the validity of results it was decided that more than one method of evaluating internalized attitudes would be employed to enable triangulation of results. A mixed method of both quantitative methods and qualitative methods needed to be employed to study the internal attitudes . The paradigm outlined in figure 3 will be the method for determining the individual responses indicating internalized math attitude in the modified model.

In the new model the first step is to determine the basic elementary math knowledge of each student. This base line will be the lowest level of math which one would expect of a college student. The next step is to determine an initial individual internal attitude (see fig. 3) of each student. This step was repeated again in the middle of the course to look for any individual changes in attitude. Concurrently external attitude indicators are monitored for the entire semester. The students performance on all class work was monitored until the final exam and course grade were complete. Figure 5 shows the methodology for new model.

FIGURE 5



Once the statistical analysis begins it will be necessary to separate students into various categories to determine which subgroups of subjects have the strongest correlations between attitude and success.

3.2 SELECTION OF THE COURSE TO BE STUDIED

The selection of the course is critical for this first large trial of a new method. The course must be one such that all or nearly all students enrolled have the required prerequisite skills necessary thus the potential to succeed. In addition, the number of students participating must be great enough to provide reliable statistical data, and the researcher must have access to all aspects of the course and student records. In addition the course must be applicable to the overall goal of aiding student placement.

To meet all these requirements I selected the WVU developmental math course. WVU refers to this course as the Math Workshop. The Math Workshop is a developmental math course, whose primary purpose is to prepare students for college algebra. The workshop is a pass/ fail course as grades for this course will not show on the student transcript. Passing constitutes an average grade of “C” or better The Workshop serves approximately 500 students per year. I have been involved with this course for the past 10 years. For the majority of the students enrolled, the Workshop is their first math course at a college or university. These students will have just undergone the current placement process. Studying this particular course makes it possible to determine the initial attitudes which the students bring to the University. One mitigating factor is that the majority of the student population of this course is not enrolled in this course by choice. Students enroll in this course for one of three reasons. Some of the students enrolling in the Workshop have a math ACT/SAT score which does not qualify them for the math course they wish to enroll in, and they choose not to take the Math Department's placement exam. The majority of the students have taken and not passed the WVU placement exam. The last group in the Workshop is made up of students who realize they are weak in math and are seeking help to improve their ability prior to taking a college level course, even though they already qualify to take college algebra. Similar groups constitute the student body of most low level math courses and as such I have decided that these reasons for enrolling must be considered when assessing student attitudes.

3.3 POPULATION SAMPLE

This study was conducted during the Fall 2003 semester. There were 229 students enrolled in the workshop this semester 35 of these students were in the researchers section of this course and a thus removed from the study. There are then 193 participating students in this study. These students were distributed among 8 sections each consisting of no more than 35 students. At WVU this is a remedial course and as such is limited by the University to the time of day when it can be offered. The classes were run two at a time concurrently beginning at 3:30pm, then at 4:30, 5:30, and the latest two starts at 6:30. The classes meet for 90 minutes each day three days per week, Tuesday, Wednesday and Thursday.

This particular semester the population of students had very diverse math backgrounds. Students ranged from the two extremes of never having taken an algebra course in high school to having taken and passed high school calculus. Another factor within this population was that 151 of the 193 students were carrying a course load in excess of 15 credit hours in addition to the workshop which is not considered for college credit.

3.4 INSTRUMENTATION

This study required the development of three separate instruments, a means to measure basic prerequisite math knowledge, a quantitative attitude assessment tool and a qualitative interview protocol. Both the prerequisite knowledge and the quantitative attitude needed to be applied to all 193 students enroled in the Workshop. Prerequisite knowledge was measured by a math test, the quantitative measure of attitude would be in the form of a survey. Due to time limitations the qualitative interview protocol could not be applied to all students and was administered to students meeting certain qualifications.

3.4.1Qualitative Interview Protocol

The qualitative interview protocol was developed within two pilot studies. The initial pilot study was conducted in the spring of 2002 in a college pre-calculus course which was experiencing 60% failure rate. Each of the 45 students interviewed were asked a series of questions corresponding to the factors of attitude listed previously in section 2.2 of this study. The interview protocol was later refined and applied again during the pilot for this study in the summer of 2003. The final version of the protocol listed below was finalized during the second pilot study. it was determined that in all 45 cases the types of attitudes determined by this protocol matched the attitudes determined by the quantitative survey being tested on a person to person basis during the same pilot study. Based upon these results in the pilot study I determined the protocol to be appropriate for the goals of this new study.

TABLE 2: QUALITATIVE INTERVIEW PROTOCOL

• **Qualitative Interview Protocol**:
o Tell me about your math background.
o Rate your ability in math from one to ten.
o Why are you taking this class?
o How do you expect to do in this class?
o Do you feel comfortable in class?
o What is your next math class?
o Do you like this class?
o Do you like this teacher?
o How do you feel about having to take the math workshop?
o How do you like this class compared to your other college classes?
o Is there anything else I should know or that you want to tell me about?

3.4.2 Quantitative attitude survey

The Quantitative attitude survey used in this study is an adaptation of an attitude survey used by the University of Maryland Physics Department. This survey's original intent was to measure attitudes about science and math as applied to Physics students. With the help of Dr. Philip Chase I have selected those questions appropriate to this study. For the initial trial early in the pilot study we decided that to maintain the validity of the questions the only modifications to the original version were to remove any reference to science. This survey has been in use by the University of Maryland since 1997 and as such has been utilized by many departments on that campus. Immediately upon application it became clear that the students did not understand many of the questions. Upon careful analysis it became apparent that the questions were intended for a higher level student than our target audience. Questions were reworded keeping with the original intent but simplifying the words and clarifying the intent of the question. The original survey was also intended for an on line application, I modified the survey to be of a scanable format. Each question had five choices based on a Likert scale, ranging from A=strongly agree to E=strongly disagree. Rankings (1-5) were determined by the context of each question and then assigned to each question. using a 5 point lictor scale. Students would read the question and respond by selecting a letter from A to E. There are 26 questions in this survey see table 3 below.

TABLE 3: QUANTITATIVE ATTITUDE SURVEY						
No.	**Question**	**A**	**B**	**C**	**D**	**E**
1	I have found mathematics to only be useful in math classes.					
2	Being/becoming proficient in math prepares you for your next math class, but that's about all.					
3	I expect to use the methods I have learned in my college level math classes in future classes					
4	Mathematics is a closed system. When you get the answer you know you have it.					
5	I've usually done well in mathematics.					
6	I often feel like I'm missing something important in math class.					
7	There are some concepts that I've encountered in math that I don't think I'll ever understand.					
8	Mathematics is intrinsically more difficult than other subjects.					
9	Anyone who works hard can do reasonably well at math.					
10	If I get bogged down in a math problem I am confident that I can usually find my way out.					
11	I don't want to take any more mathematics courses than I absolutely have to.					
12	I enjoy tackling challenging math problems					
13	Mathematics is something I need to be able to use in other courses, but it's not particularly interesting on its own.					
14	A good understanding of mathematics is necessary for me to achieve my career goals.					
15	Beyond passing a required course, I don't see the reason for learning the mathematics I am studying.					
16	Only very few specially qualified people are capable of really using mathematics effectively.					
17	In solving a mathematics problem, if my calculation gives a result that differs significantly from what I expect, I would tend to trust the calculation rather than my intuition.					

18	A significant problem in this course is being able to memorize all the information I need to know.						
19	When I solve most exam or homework problems in math, I usually focus on the equation and don't explicitly think about the underlying concepts.						
20	Mathematical problem solving means being able to find the correct equation to plug the given numbers into.						
21	I do not understand mathematical results in an intuitive sense; they must just be taken as givens.						
22	Understanding "why" a math problem has a particular answer is often as important as knowing what the answer is.						
23	In mathematics, exploring ways to solve a problem is at least as important as getting the "right" answer.						
24	Mathematics is essentially an accumulation of facts, rules, and formulas to be memorized and used.						
25	I have often felt frustrated in this course.						
26	I feel I am learning relevant techniques in this course.						

3.4.3 Prerequisite test

The prerequisite exam was taken from a seventh grade arithmetic worksheet. This exam does not include fractions or decimals. It is a test of the simple concepts of multiplication, division, addition and subtraction, including the use of signed numbers. All numbers were limited to two digits. The test is timed, and is 45 minutes in duration. The content of this exam came about through an interaction between the coordinator for the Workshop and three of the veteran instructors for the course, including myself. It was the consensus of this group that any student who possessed these very basic skills would have the potential to be successful. The pretest in its entirety is in the appendix of this study, I have included a representative sample of the questions.

o**Sample:** **8+48=** **-9- -49=** **28- -91=** **-41 – 14 =**

26 x - 45= **90 ÷ 6 =** **76 ÷ 4 =** **-6 + 6 =**

3.5 PROCEDURE

An agreement was reached with the course coordinator that participation in this study would result in bonus points awarded to the student. Also, with the exception of the qualitative interviews, all tests and surveys would be given during regularly scheduled class time. The interviews would be scheduled throughout the semester outside of regular class time.

The assessment of student performance for the workshop consists of: graded daily in class worksheets, checked daily homework assignments, four regularly scheduled exams, a comprehensive final exam. Points are also awarded each day for attendance. There are a total of 700 points available; a student needs to earn 490 to pass the course.

A procedure for the new model was developed during a pilot study conducted in the summer of 2003. All students were assigned a coded id number to protect their identity. All students on the first day of class were given the prerequisite assessment tool to establish base line math knowledge for each student. Scores on this test ranged from a low of 18/100 to a high of 99/100 with a mean of 73.1.

On the second day of class the students were given the first of two quantitative surveys. 193 students participated by taking this initial survey. There is a point in the workshop where the course material gets decidedly more difficult. For the past several years this has been a turning point for many students. For this reason the second attitude survey(exactly the same as the first) would be administered one more time after this critical point had been reached but before the final exam.

Students would also be asked to participate in the qualitative interview process outside of class time. In order to receive the bonus points for participating in the interview process a student was required to be interviewed twice during the semester, once between exams 1 and 2 and next after exam 3. 37 of the 193 students participated in both interviews.

Before the course began each course instructor was given an excel spreadsheet which included the class list for his/her section, a column for attendance by day, home work and worksheets by each day, columns for each of the four regular exams and a place for the final. The classroom performance of each student was recorded for the entire semester and returned to be analyzed at the end of the semester. The daily records were crucial in monitoring classroom behavior and associated trends in achievement.

It was decided that only those students who participated in the pre-test and both quantitative surveys would be included in the quantitative analysis. There were 106 of 193 who met this requirement. In an effort to triangulate the various assessment tools it was determined that for the qualitative assessment only those students who participated in both quantitative surveys, both qualitative interviews and took the pre-test would be considered. There were 19 of the 37 who met this requirement.

3.6 STATISTICS

The data consisted of 26 questions designed to measure the students' attitudes towards mathematics. Table 4 lists each question and the corresponding assigned rank to each of the student's answers. Data recoding was performed based on the value of assigned rank. A total score for each student was calculated by summing the coded values of each student's survey.

Table 4. Survey Questions and Rankings

							Good Attitude?
No.	**Question**	**A**	**B**	**C**	**D**	**E**	**True/False**
1	I have found mathematics to only be useful in math classes.	1	2	3	4	5	FALSE
2	Being/becoming proficient in math prepares you for your next math class, but that's about all.	1	2	3	4	5	FALSE
3	I expect to use the methods I have learned in my college level math classes in future classes	5	4	3	2	1	TRUE
4	Mathematics is a closed system. When you get the answer you know you have it.	1	2	3	4	5	FALSE
5	I've usually done well in mathematics.	5	4	3	2	1	TRUE
6	I often feel like I'm missing something important in math class.	1	2	3	4	5	FALSE

7	There are some concepts that I've encountered in math that I don't think I'll ever understand.	1	2	3	4	5	FALSE
8	Mathematics is intrinsically more difficult than other subjects.	1	2	3	4	5	FALSE
9	Anyone who works hard can do reasonably well at math.	5	4	3	2	1	TRUE
10	If I get bogged down in a math problem I am confident that I can usually find my way out.	5	4	3	2	1	TRUE
11	I don’t want to take any more mathematics courses than I absolutely have to.	1	2	3	4	5	FALSE
12	I enjoy tackling challenging math problems.	5	4	3	2	1	TRUE
13	Mathematics is something I need to be able to use in other courses, but it's not particularly interesting on its own.	1	2	3	4	5	FALSE
14	A good understanding of mathematics is necessary for me to achieve my career goals.	5	4	3	2	1	TRUE
15	Beyond passing a required course, I don't see the reason for learning the mathematics I am studying.	1	2	3	4	5	FALSE
16	Only very few specially qualified people are capable of really using mathematics effectively.	1	2	3	4	5	FALSE
17	In solving a mathematics problem, if my calculation gives a result that differs significantly from what I expect, I would tend to trust the calculation rather than my intuition.	1	2	3	4	5	FALSE
18	A significant problem in this course is being able to memorize all the information I need to know.	1	2	3	4	5	FALSE
19	When I solve most exam or homework problems in math, I usually focus on the equation and don’t explicitly think about the underlying concepts.	1	2	3	4	5	FALSE
20	Mathematical problem solving means being able to find the correct equation to plug the given numbers into.	1	2	3	4	5	FALSE
21	I do not understand mathematical results in an intuitive sense; they must just be taken as givens.	1	2	3	4	5	FALSE
22	Understanding "why" a math problem has a particular answer is often as important as knowing what the answer is.	5	4	3	2	1	TRUE
23	In mathematics, exploring ways to solve a problem is at least as important as getting the "right" answer.	5	4	3	2	1	TRUE
24	Mathematics is essentially an accumulation of facts, rules, and formulas to be memorized and used.	1	2	3	4	5	FALSE
25	I have often felt frustrated in this course.	1	2	3	4	5	FALSE

26	I feel I am learning relevant techniques in this course.	5	4	3	2	1	TRUE

To handle the amount of raw data obtained from nearly 200 students, a new program needed to be written to read the survey Scantron forms. The software utilized existing scanning equipment already in place in the Math Department. This program recorded the responses of each student on every question. The records were then stored by a student identifier in an array that will make available a record of the individual's particular response to a particular question. Each student in the course was assigned a number specific to them. This number served to both protect their identity and to track and connect all student records. This same number provided the connection between the student's responses on the quantitative scantron attitude survey, the qualitative survey interviews and any course work. This made it possible to assess the individual student's attitudes and track any changes in attitude that occurred during the semester.

A reliability analysis was performed for each survey to check for the internal consistency of the survey. Questions found to be uncorrelated with other questions were excluded from the analysis. Students' point scores (for the entire class and the total for four tests) from the algebra class were then correlated with the scores on the 1^{st} and 2^{nd} surveys using a number of parametric and non-parametric statistical tests.

Linear regression was performed using the point scores as response variables and the survey scores as predictor variables. Because the student's for this type of class/workshop were given a pass or fail grade, logistic regression was also performed.

Correlations between point scores and survey scores were determined and regression analyses (linear and logistic) were performed for each of the groups for both surveys.

The statistical procedures used in the analysis portion of this study were developed in the field of survey statistics. A statistics program, SPSS 9.0 was provided by the WVU. dept. of Statistics for the analysis of this study. Statistics will be used to check the reliability of the attitude survey, to analyze the raw survey scores and to perform a correlation analysis of several differing strategies. For a further description of the statistics used see the appendix.

CHAPTER IV

4.1 QUANTITATIVE DATA

4.1.1 Reliability Analysis

One method to verify the reliability of the survey tool used would be to look at the consistency of student responses from survey 1 to survey 2. However as the instructors worked with the students they were particularly aware of attitudes due to the nature of this study. Each instructor reported positive changes in observed attitude of individual students as they became more successful. This would indicate there would not necessarily be response consistency over time.

Another type of reliability analysis allows an investigation of the internal consistency of the survey instrument. The measurement scale and the questions that comprise the survey are checked for scale reliability. Reliability analysis provides information about the relationships (or correlations) between individual items. Questions that are uncorrelated or negatively correlated with other questions can be identified and can be excluded from the survey or recoded. An overall index of the repeatability of the scales as whole can also be measured using this analysis. This will check for the consistency of the subject's interpretation of the questions. The literature Nunnally (1978) has indicated that an Alpha of .7 or above indicates reliability. A reliability analysis of this type was performed using SPSS 9.0 to determine the internal consistency of the survey administered.

The alpha coefficient for the first survey set of questions was determined to be 0.7962, well within the accepted range to demonstrate reliability. An item by item analysis indicated that four variables (Q4, Q23,Q24,Q25) had negative average item total correlations for the survey. The four suspect questions were re-examined and determined to be ambiguous in nature. These survey questions (Q4,Q23,Q24,Q25) were excluded from the analysis. The alpha coefficient for the new data set excluding these questions was calculated as 0.8672.

A second reliability analysis was also performed on the second survey. An alpha of .8277 was found. The number of students taking the second survey (106) was also much lower than the number of students taking the first survey (193). As previously stated the second survey was by design administered after the subject material had become more difficult. The resulting drop in the number of students responding to the second survey was due to the unusually high attrition rate for this particular semester. For this case, two of the same four questions (Q24 and Q25) were again found to have negative corrected item-total correlations. These were excluded from the analysis involving the second survey and an alpha of .8750 was found. The SPSS output for the reliability analysis with all questions included is shown as follows:

Table 5 . Alpha Coefficients	Alpha Coefficient
Survey 1	0.7962
Survey 1 w/ Q4, Q23, Q24, Q25 excluded	0.8672
Survey 2	0.8277
Survey 2 w/ Q24, Q25 excluded	0.8750

Based solely upon the item-total correlation for survey 1 and 2, the sign changes for questions 4 and 23 cannot be said to illustrate a shift in the attitudes of students for these questions. With 87 students no longer regularly attending class, an argument could be made that those are the student responses responsible for the negative correlations.

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By performing a reliability analysis on each of the surveys and determining which questions to exclude from the survey, the alpha coefficients were increased for survey 1 from .7962 to .8672 and for survey 2 from .8277 to .8750, making the survey instrument more reliable.

4.1.2 Descriptive Statistics

4.1.2.1 Survey 1 and 2

A rating for each student's attitude was obtained by summing the total of the students' survey responses (ref. section 3.5). The higher the score the more positive the students attitude and conversely lower scores would describe a more negative attitude. Literature within survey statistics (Nunnally 1978) has shown that the more normally distributed the survey responses are the more likely the survey is to be reliable. The descriptive statistics for the first survey distributed with the four questions (Q4, Q23, Q24, and Q25) excluded are as follows:

Table 6: Descriptive Statistics For Survey 1 With Q4, Q23, Q24, And Q25 Excluded

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Survey1wDel	193	80.8%	46	19.2%	239	100.0%

Descriptives

			Statistic	Std. Error
Survey1wDel	Mean		67.4508	.8539
	95% Confidence Interval for Mean	Lower Bound	65.7665	
		Upper Bound	69.1351	
	5% Trimmed Mean		67.5564	
	Median		67.0000	
	Variance		140.738	
	Std. Deviation		11.8633	
	Minimum		37.00	
	Maximum		106.00	
	Range		69.00	
	Interquartile Range		16.0000	
	Skewness		-.086	.175
	Kurtosis		.090	.348

For the purpose of comparing the overall attitude of one student to another we can observe that the mean attitude reference number is 67.45. Students who have a rating above this will be considered to have a better than average attitude and conversely students who have a rating below this value will be considered to have a less than average attitude.

The histogram of the scores for survey 1 with questions 4, 23, 24, and 25 excluded is shown as follows:

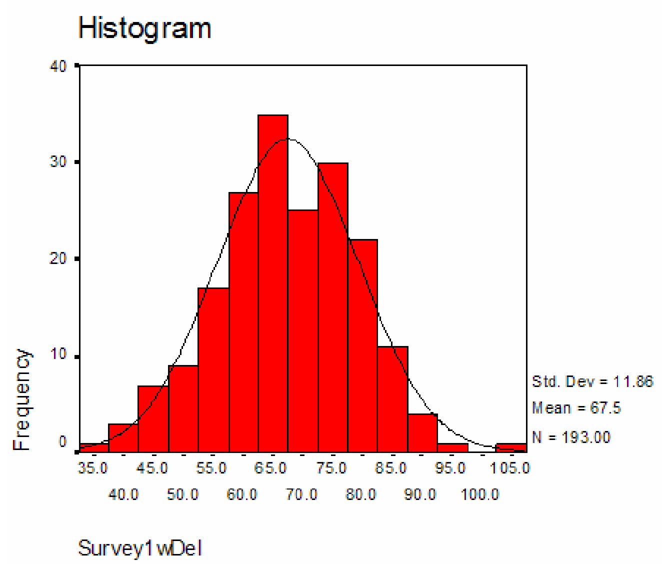


Figure 6

It is important to note the almost perfectly normal distribution. The literature on survey statistics states that the more normal the distribution the more reliable the survey.

The descriptive statistics for the second survey with the two questions excluded are as follows:

Table 7: Descriptive Statistics for Survey 2 with Q24 and Q25 excluded

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Survey2wDel	106	44.4%	133	55.6%	239	100.0%

Descriptives

			Statistic	Std. Error
Survey2wDel	Mean		71.3962	1.2876
	95% Confidence Interval for Mean	Lower Bound	68.8431	
		Upper Bound	73.9494	
	5% Trimmed Mean		71.1583	
	Median		71.0000	
	Variance		175.746	
	Std. Deviation		13.2569	
	Minimum		41.00	
	Maximum		110.00	
	Range		69.00	
	Interquartile Range		17.0000	
	Skewness		.306	.235
	Kurtosis		-.013	.465

The histogram of the scores for survey 2 with questions 24 and 25 excluded is shown as follows:

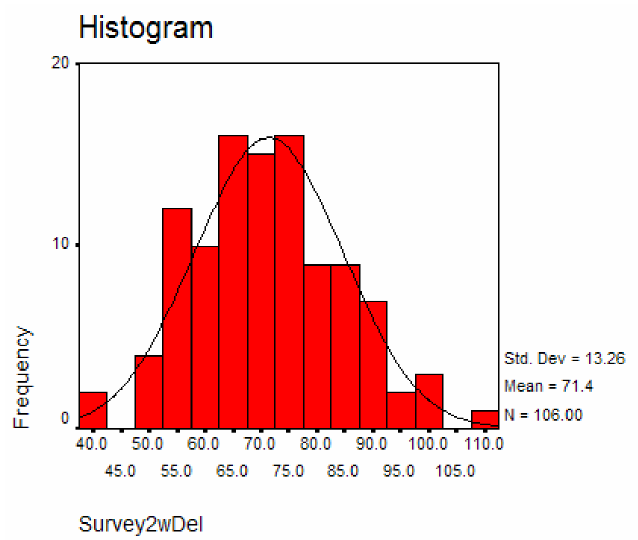


Figure 7

Again note the mean for survey to be 71.3962 and the nearly perfect normal distribution of survey 2. Recall that the more normal the distribution the more reliable the survey.

4.1.2.2 Pre-test (arithmetic test)

The descriptive statistics for the 100 question prerequisite arithmetic test are as follows (scores represent 1 pt for each correct response):

Table 8. Descriptive Statistics for the Arithmetic Test Scores (Arithmetic)

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Arithmetic	204	93.6%	14	6.4%	218	100.0%

Descriptives

			Statistic	Std. Error
Arithmetic	Mean		73.0784	1.1550
	95% Confidence Interval for Mean	Lower Bound	70.8012	
		Upper Bound	75.3557	
	5% Trimmed Mean		73.9575	
	Median		76.0000	
	Variance		272.122	
	Std. Deviation		16.4961	
	Minimum		18.00	
	Maximum		99.00	
	Range		81.00	
	Interquartile Range		25.5000	
	Skewness		-.759	.170
	Kurtosis		.096	.339

The mean for this assessment was 73.0784, this score is the number correct out of 100 questions on a seventh grade arithmetic test. This score was surprising low given that the students participating were all at least college freshman.

A histogram for the arithmetic test scores is shown as follows:

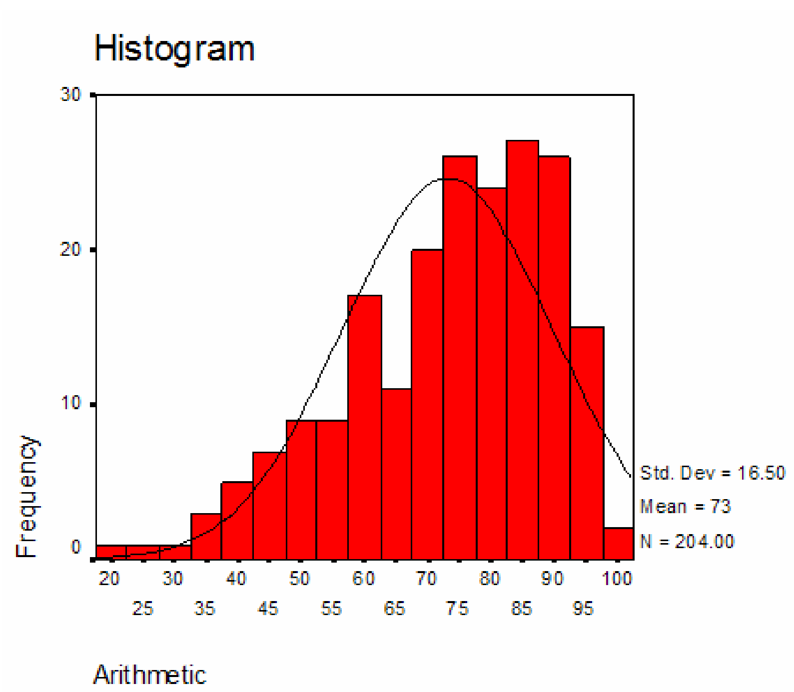


Figure 8

This pretest was based upon a seventh grade work sheet hence, for college students; one would expect a shift to the right from a normal distribution.

4.1.3 Correlation Analysis

4.1.3.1 Correlation Variables

This study wished to use a correlation variable which denotes achievement. The original variable used for correlation analysis with the two survey scores was final total point score. This was the total points earned by the student for the entire course. This variable proved to not be reliable. This course is by design pass/fail in which students pass simply by earning the prescribed minimum number (490) of points. It became readily apparent that once students had achieved a passing total they no longer had a need to earn more points. It was possible for a high achieving student who received "A's" on all the exams and completed all required assignments to have a passing total number of points without taking the final exam. This is done as an incentive which allows students to concentrate on finals which will count on their GPA rather than the workshop which does not. For the most part the highest achieving students did not take the final exam (200 pts), while the lower performing students took all four exams and the final exam. This resulted in some cases where lower performing students attained higher point totals than the top students. It was found that achievement would best be measured by the scores of the students on the four in class exams. Students must take all four exams to pass the course. it was decided to use total points earned on the four course exams as the correlation variable.

4.1.3.2 Correlations

Statistics measuring correlations between variables can be either distribution dependent parametric or distribution free non-parametric measures. One parametric measure of correlation is known as Pearson's product moment correlation coefficient. . Non-parametric statistics measuring correlation are often based on ranks (for n measurements, the smallest value is assigned rank 1, the largest value is assigned rank n) of the two variables. Examples of these correlations include Kendall's tau and Spearman's rho correlation coefficients. All correlations were run using Pearson product moment, Kendall's tau and Spearman's rho.

One original premise for this investigation was that attitude would have varying effect on deferring levels of students. It was decided that since prerequisite knowledge is currently used to place students this would provide the basis by which to separate students into various groupings to investigate correlations between achievement and attitude. Students were segregated based upon their score on the pretest in four different ways and correlations run for each grouping scheme, each grouping scheme becoming more specialized(pretest wise) in order to fine tune correlations.

The four different grouping were; a single large grouping(the same manner as found in the literature), three distinct groups by standard deviation from the pretest mean, a 10 point scale (to separate the students into 10 groups), a moving 20 point window using 10 point increments (this sliding window will help refine the results per group).

4.1.3.2.1 Correlation using one large group

The first correlation analysis was performed for both surveys using a single large group. Table 9 lists the correlations found between the total points scores on the four tests and the 1st and 2nd survey scores. It should be noted that for all of the bivariate correlations in the following analysis cases are excluded list wise, so that if either one of the values of the pair is missing, that pair is excluded from the analysis. In addition, a * denotes significance at the 0.05 level and a ** denotes significance at the 0.01 level.

Table 9. Correlation between surveys 1 and 2 and total point score for the four tests (Test Totals)

Coefficient	Correlation Test Totals w/ Survey 1(N=185)	Correlation Test Totals w/ Survey 2(N=105)
Pearson product moment	0.280**	0.377**
Kendall's tau	0.201**	0.282**
Spearman's rho	0.291**	0.389**

The majority of researchers use Pearson's Product Moment for their descriptive. These results for our initial run are within the same range as reported in the literature, .28-.377.

4.1.3.2.2 Correlation using Three groups

The scores on the arithmetic test were used to divide the students into three groups. This division was based on the standard deviation of the arithmetic test scores. One standard deviation (16.5) from the mean (73.1) was used as the division for the groups. A correlation between the total point scores and the survey scores were made for each of the three groups (Group 1 is students who scored lower than 56.6 on the arithmetic test, Group 2 is students scoring between 56.6 and 89.6, and Group 3 is students who scored more than 89.6 on the arithmetic test). These are denoted Group = 1,2,3 in Tables 10and 11.

Table. 10Correlations for the Test Totals and the Survey 1 Scores for 3 Groups based on +/-1 Std. Deviation (16.5) from the mean (73.1) of the Arithmetic Test Scores

Group	N	Pearson PM	Kendall's tau	Spearman's rho
1	34	0.389*	0.302**	0.406**
2	124	0.278**	0.195**	0.290*
3	27	0.084	0.087	0.151

Table. 11Correlations for the Test Totals and the Survey 2 Scores for 3 Groups based on +/-1 Std. Deviation (16.5) from the mean (73.1) of the Arithmetic Test Scores

Group	N	Pearson PM	Kendall's tau	Spearman's rho
1	18	0.801**	0.574**	0.713**
2	75	0.358**	0.264*	0.368**
3	12	-0.054	0.047	0.046

As can readily be observed the correlations dramatically increased for the mid to lower students and decreased for the upper division. Our results are now beginning to exceed that reported within the literature.

4.1.3.2.3 Correlation using Ten groups

A grouping was also made using the arithmetic scores so that the students were divided into ten groups. The coding based on the arithmetic test scores is as follows: 1=[0,10), 2=[10,20), 3=[20,30), 4=[30,40), 5=[40,50), 6=[50,60), 7=[60,70), 8=[70,80), 9=[80,90),10=[90,100) .

Table 12.Correlations between the Test Totals and the Survey 1 scores with binning using increments of 10 for the arithmetic test scores (variable: DivBin10)

Group	N	Pearson PM	Kendall's tau	Spearman's rho
Missing	0	0.396	0.200	0.257
1	0	NA	NA	NA
2	1	NA	NA	NA
3	1	NA	NA	NA
4	3	0.854	0.333	0.500
5	11	0.477	0.500*	0.708**
6	18	0.541*	0.364*	0.579**
7	30	0.285	0.171	0.264
8	42	0.074	0.053	0.072
9	46	0.346**	0.271**	0.405**
10	27	0.084	0.087	0.151

Table 13.Correlations between the Test Totals and the Survey 2 scores with binning using increments of 10 for the arithmetic test scores (variable: DivBin10)

Bin	N	Pearson PM	Kendall's tau	Spearman's rho
Missing	2	0.396	NA	0.257
1	0	NA	NA	NA
2	0	NA	NA	NA
3	0	NA	NA	NA
4	4	0.776	0.667	0.800
5	7	0.500	0.350	0.609
6	10	0.725**	0.584**	0.717**
7	14	0.181	0.268	0.319
8	33	0.286	0.179	0.246
9	23	0.487**	0.353**	0.505**
10	12	-0.054	0.047	0.046

As can be seen in table 12 and 13, the values of correlations are beginning to establish a trend, in that the lower subgroups are demonstrating strong correlations while the upper groups(except group 9) are exhibiting lower correlations.

4.1.3.2.3 Correlations: using a Moving Window of 20 Points with increments of 10 points for the Arithmetic Test Scores

In an effort to further fine tune the groupings where the strongest correlations will occur I created a grouping scheme where a 20 point window would be slid up and down the scale in increments of 10 and the correlations checked after each trial. A window of 20 points on the arithmetic was also used in increments of 10 so that the coding was as follows: 1=[0,20), 2=[10,30), 3=[20,40), 4=[30,50), 5=[40,60), 6=[50,70), 7=[60,80), 8=[70,90), 9=[80,100) (variables MovWin1, MovWin2,…,MovWin9).

Table 14. Correlations between the Test Totals and the Survey 1 Scores for the moving window binning.

Window	N	Pearson PM	Kendall's tau	Spearman's rho
1	1	NA	NA	NA
2	2	NA	NA	NA
3	4	0.947*	0.667	0.800
4	14	0.533*	0.447*	0.670**
5	28	0.554**	0.384**	0.561**
6	48	0.338**	0.233*	0.355**
7	72	0.217*	0.150*	0.212*
8	88	0.229*	0.166*	0.248*
9	73	0.244*	0.193**	0.290**

Table 15. Correlations between the Test Totals and the Survey 2 Scores for the moving window binning

Window	N	Pearson PM	Kendall's tau	Spearman's rho
1	1	NA	NA	NA
2	2	NA	NA	NA
3	4	0.776	0.667	0.800
4	11	0.607*	0.472*	0.647*
5	16	0.658**	0.509**	0.640**
6	24	0.358*	0.329*	0.438*
7	47	0.277*	0.319**	0.435**
8	56	0.363**	0.243**	0.341**
9	35	0.299*	0.219*	0.313*

This method further defined the emerging pattern of the lower groupings having the highest correlations between attitude and achievement.

4.1.4 Quantitative results

The first correlation analysis was run taking all participating students as a single group and running correlations between the attitude survey and total points for the course. The results were in line with other studies in the field, with correlations running, .282, .377 and .389, dependent upon the method used. This level of correlation could be considered low but significant as reported within the current literature. The inspiration for this study was to break the groups into smaller segments and investigate specific populations of the student body. The challenge was then to look at the changes in correlation by smaller groups and pinpoint the strongest correlations within the overall population. Groups were selected and ordered by the student's scores on the arithmetic pre-test. The first step was to separate the groups by a single standard deviation resulting in three groups (reference tables 10 and 11). Next students were categorized by ranges of their pre-test scores using increments of 10 (out of 100). The results in utilizing10 bins or groupings for correlations are shown in tables 12 and 13. Finally a sliding window of 20 points was used. The 20 point window was progressed every 10 points and correlations were run at each interval (reference tables , 14 and 15).

As different grouping were established and correlations run it became apparent that the strength of the correlations between attitude and achievement varies dependent upon the grouping of the students. Regardless of the grouping method used or the statistical method employed, whether Pearson PM, Kendall's tau or Spearman's rho, the trends were always constant. The students with the lowest scores on the arithmetic pretest showed the highest positive correlation. As the scores on the pre-test increased the correlations between attitude and grades decreased. The results are of a strength as yet not reported in the mathematics education literature and has surpassed the results of Lalonde and Gardner whose study was the impetus of this research.

4.2 QUALITATIVE RESULTS AND ANALYSIS

4.2.1 Qualitative Study Introduction

During the same time period in which the quantitative study was active, a qualitative interview protocol was also employed. The qualitative portion of this study was used to triangulate the quantitative survey data. The qualitative study supported the quantitative study by showing the consistency of attitudes when comparisons are made from survey results to interview results with individual students. This served to establish the reliability of the survey questions and methods utilized throughout the study. Another purpose of the qualitative interview process was that the quantitative survey lacked the ability to explain the underlying reasons behind the observed attitudes. The interviews showed that the attitudes displayed in the mathematics classroom are not solely based upon mathematics but rather are an aspect of both the subjects preconceived notions about mathematics and the classroom atmosphere.

4.2.2 Determining Attitude (qualitatively)

A qualitative interview protocol was administered twice during the semester to 37 of 193 students participating in a pre-college algebra course. The interview protocol consisted of 22 questions (see table 2) designed to provide an in-depth lens of the attitudes of students in this course. Participation by students in the interview process was strictly voluntary. All interviews were audio taped and transcribed. It was decided that only those interviewed students, who participated with both semester interviews, took the arithmetic pretest and both quantitative surveys, would be included in this portion of the study. 13 of the 37 students interviewed fit this requirement. This relatively low number of complete data sets is explained by the unusually high attrition rate experienced during the workshop this particular semester. This particular semester experienced a 40% failure rate, the highest within the past 7 years.

The qualitative portion of this study assesses attitude through two different vehicles. First, an interview process was utilized applying an interview protocol developed in a pilot study for this application. Each question within the protocol addresses documented factors which influence attitude (see section 2.2). Each interview was transcribed and the responses to each question evaluated, to generally determine the attitude demonstrated during the interview process by that particular student. Only those students who participated in two interviews (spread over the semester) were considered for this portion of the study. A comparison of each individual was made between the first and second interviews to look for any changes in observed attitude.

The other vehicle is the course records themselves. Previously I have stated that one hypothesis for this study is that, for many students, motivation and effort is determined by their attitudes about mathematics, the atmosphere within the mathematics classroom, and the student's beliefs about their own ability. Effort and motivation are the most obvious indicators of certain attitudes. Based upon this, I used attendance records, homework grades and the number of completed assignments as indicators of motivation. Each interview was dated and recorded as were attendance records, all course work assignments and exams. It was then possible to date and track observed behavior in terms of the interviews and look at any behavioral changes accompanying any attitude changes..

4.2.3 QUALITATIVE RESULTS

In an effort to triangulate the various assessment tools it was determined that only those students who completed the initial arithmetic assessment, both quantitative surveys and participated in two qualitative interviews, would be considered. The transcribed interviews (included in the appendix) of those 13 students who met the criteria were assessed and compared with that student's course records. Included in each comparison was a ranking based upon that student's arithmetic pre-test as performed in the quantitative portion of this study. This ranking is the bin location used for the quantitative analysis, they are listed by the bin number and the range of scores for that bin; 1= [0,10), 2=[10,20), 3=[20,30), 4=[30,40), 5=[40,50), 6=[50,60), 7=[60,70), 8=[70,80), 9=[80,90), 10=[90,100). As noted previously the quantitative portion of this study indicate that students having a low score on the arithmetic test (Bins 4-6) had high correlation between point scores and the survey scores. As the scores on the arithmetic test increased (Bins 7,8,9,10), the correlation between point scores and survey scores decreased compared with bins 4-6 (ref. table 13).

TABLE 16 Interviewed student records

Student ID	**Pre-test**	**Survey-1**	**Survey-2**	**pass/fail**		**Quantitative binLocation**
2	79	49	40	F		8
3	87	90	91	P		9
4	50	90	100	P		6
5	76	44	67	P		8
7	79	89	92	P		8
9	96	60	58	F		10
13	74	68	50	F		7
15	88	84	88	P		9
19	64	75	70	F		7
21	34	50	51	F		4
23	59	77	78	P		6
24	95	94	93	P		10
34	77	76	51	F		8

The correlations between the attitude survey results and the student outcomes are further supported by this qualitative study. I have included below excerpts from student interviews which are representative of the attitudes encountered with each student. It is interesting to refer to table 16 using these bin numbers as we look at the qualitative interviews. In all but one case(student #19) the attitudes displayed during interviews corresponded to the attitudes determined by the survey. This single case will be explained latter on. The students interviewed can be categorized in one of four ways.

The students either; demonstrated the ability to succeed but failed, demonstrated that they were at risk of succeeding but still succeeded, demonstrated that they were at risk and failed or demonstrated that they were not at risk and passed the course.

Four of the thirteen students interviewed demonstrated the potential to succeed but failed the course. These students 9,34,2 and 13 demonstrated poor attitudes during the interview process which correlates with low attitude ratings from the survey results. Student # 9 scored the highest recorded score on the pre-test and clearly possessed the potential to do well in the workshop. Her attitude as shown by both the surveys and interviews shows clearly why she did not pass this course. Students 34 and 13 in particular demonstrate the importance which attitude has upon performance within the math classroom. Both these students started with a good attitude and were succeeding within the course. A situation with the teacher arose which can be identified with a change in apparent attitudes as shown by both second qualitative interviews and the second quantitative survey. These students failed every portion of the course from the point where they developed a poor attitude.

Student number five appeared to be in this same category but part way through the course developed a good rapport with the instructor. This changed his apparent attitude which can be tracked by both his second interview and his second survey. As his attitude improved so did his grades and his outcomes.

Two of the students interviewed ,numbers 4 and 23, had scored so low on the seventh grade level arithmetic pre-test that it appeared very unlikely they could succeed in this course. Both students displayed very positive attitudes both by their interviews and by the surveys. Both passed the course overcoming any weaknesses the originally had.

Student number 19 did not at first appear to fit with the patterns of attitude that were emerging within this study. She demonstrated the ability to succeed based upon her pre-test and she also demonstrated a positive attitude regarding mathematics, yet was still failing the course. It was not until her first interview that the reason became clear (see excerpts below). She had a good attitude about math but a poor attitude about taking the course, specifically the lateness of her particular class. This student was carrying an 18 hour course load in addition to the workshop, her section met from 7 to 8:30 pm, she simply could not maintain the degree of effort required to be successful.

For these students interviewed there clearly exists a connection between attitude displayed and homework behavior and final outcome. What follows are examples of the case by case assessment.

Interview number 34 was a female subject who began this course with an attitude better than the average. She demonstrated competency with the initial arithmetic test scoring a 77(4 points above the average). Her initial interview indicated reluctance toward this math course but a determination to complete the course work and get on with her degree work. Her initial quantitative survey also indicated an attitude (76) significantly better than the average (67.45). From the onset of the course until the second exam all assignments were completed accurately and on time. Her scores on the first two regular class exams were a 85 and a 70. During her first interview she demonstrated confidence in passing the course, when asked: **Q:** how much effort are you putting into the course?, she responded **A** " not a lot of effort because I don't have too". A follow up question indicated a general acceptance of the course and a tolerance of the course work. **Q:** Sounds like you are having an easy time with the course? **A:** **"**Yeah, its not bad." At the time of the first interview she indicated liking the teacher. Her second interview revealed a sharp decline in apparent attitude, she now demonstrated a strong dislike for this particular class and teacher. **Q:** Do you still feel comfortable in the class room and with the teacher? **A:** " Asking questions, I never do, because I get talked to condescendingly." **Q**: How do you feel, still like your teacher? A: Seems like a nice person I guess." A follow up question **Q**: How about as a teacher, not as a person? **A**: "NO , I think she thinks this class is a joke, like us. **Q:** Do you think she wants to be there? **A**: "NO, definitely not!" **Q:** Do you think she enjoys teaching? **A:** "Yeah, but probably not us. This student stopped completing the assigned home work after the seventh week of the course and after earning a high C on the first exam failed all the remaining exams. Her second quantitative attitude survey dropped 25 points to a 51 from her initial attitude of 76. This student stopped attending class regularly and turned in 60% of the home work assignments after the second exam. She failed the course.

Interview number 9 was a female student who had scored among the highest on the arithmetic test (96/100). Her initial quantitative survey (60) demonstrated a below average attitude toward math. Her second quantitative survey was even lower, with a 58. It was not until the qualitative interview process that the extent of her feelings was revealed. Both interviews demonstrated a completely negative attitude about math and the class. **Q:** Did you get good grades in high school math? **A:"** No. Cause I don't see a point in it. I saw there is no driving motivation that I am going to use this later in life. It is like I am only using this to get by and graduate. Like that is not enough motivation for me". **Q:** Tell me anything you think I should know about? **A:** "I don't feel like I'm going to be using this necessarily. I have to have it for my major. I just don't feel that I'm necessarily going to need to understand a lot of the problems with math we have to do. The computer is smarter than me and the computer knows what it is doing more than I do. Like if I just plug it in". This student sporadically completed homework assignments, missed at least one class per week. She passed the first two exams and never got above a 35% on another grade. Even though all indicators were that she had the potential to succeed, and had succeeded on the first two in -class exams, she failed the course.

Interview number 13 was a female student who scored a 74 on the arithmetic pre-test, placing her in bin # 7. Her initial quantitative survey score was a 68 , just above the average of 67.45. At the onset of the course her observed behavior indicated a motivation to succeed. She completed the first 7 home work assignments on time and with perfect scores. She also had perfect attendance for the first five weeks. By the time of her first interview a conflict with her particular teacher had begun to emerge as demonstrated by the following excerpt from the first interview. **Q:** What do you think about the workshop in general? **A:** I think it is terrible, I don't think it is enough for us because there are reasons we are not in college algebra. I think we deserve more attention than that. Our teacher doesn't go more than 45 minutes everyday and we're supposed to go till 5:30. It's not helping me at all. I'm doing terrible in there right now. **Q:** Do you think the pass/fail is part of the reason people don't take it seriously? **A:** I think the people take it seriously, but the professor doesn't take it seriously. We go for extra help, and we're told we should already know these things. There are reasons we are not in college algebra, it is remedial. I never did badly in math before. The lowest I got in math was C+, because of the SAT and placement test I am in here and I am doing terrible in this class. I don't understand. We are not getting the attention we need. Things aren't explained how they are supposed to be. Maybe that is because I am a freshmen and I think they need to be explained more, but for me math needs to be explained to the T. I don't hate math, I actually enjoy it, but when it is not taught to me, I get frustrated and I end up thinking I can't do it because I am told when I ask a question in class that I should already know something.

This student began demonstrating a change in observed motivational behavior near the midpoint of the course. Homework assignments were turned in but not complete nor correct. By the time of the second quantitative survey her attendance had become sporadic. Her second quantitative attitude survey score was a 50, a drop from the 68 seen earlier. Some excerpts from her second interview demonstrate the evolving conflict within the class. **Q:** What do you think about the workshop in general? **A:** I think it is terrible, worse than when we talked before. The professor doesn't take it seriously. Like I told you before this is just a bad teacher **Q:** So you actually feel bad in class? **A:** Yes. **Q:** Do you think your teacher wants to be there? **A:** No, **Q:** Do you think she enjoys teaching? **A:** She just doesn't want to be there. **Q:** Anything else I should know? **A:** This woman should not be teaching if she does not want to be here. This student had passed the first two exams with low C's, but did not pass another exam for the remainder of the course. Exam 3 was a 35%, exam 4 a 20% and the final was a16%. This student failed the workshop.

Interview number 2 was a female student who had completed calculus in high school. She scored a 79 on the arithmetic pre-test (bin # 8), but both the qualitative and quantitative assessment tools showed a poor attitude regarding math. Her initial attitude survey was a 49, (18.45 points below the average). Her second survey dropped to a 40. At the time of the first qualitative interview this student had earned an 85 on the first exam and a 70 on the second and had already missed two classes and 1 homework assignment. The first qualitative interview revealed not only her feelings about math but also her goals and expectations. **Q:** In general, did you like math in high school? **A:** No. I hated it. **Q:** If you had to rate your ability in math 1-10? **A:** 3 **Q:** Do you really get nervous when you take math tests? **A:** Yeah, I generally don't know what's going on. **Q:** Do you work at it pretty hard, do you do all the homework? **A:** Usually at the beginning, then at the end I get frustrated and stop doing it. **Q:** Why did you end up in workshop? **A:** I was forced to. **Q:** How do you feel about the workshop so far? **A:** I think it is good, and goes at a decent pace. **Q:** Anything else you feel strongly about that I should know? **A:** A lot of times I sit there and I'm so stressed out about this class and I'm never going to use it. Like I know for a fact I'm never going to have to do this, this, this…you know. Why do I have to be so stressed out about something that is not going to be used……. At the time of the second qualitative interview this student had stopped attending class and handing in completed homework assignments. Her scores on the last two exams were a 50/100 and a 25/100 respectively. She earned a 32% on the final exam. As she had predicted during her first interview she stopped doing the homework and attending class. She summed up her effort with this statement during the second interview. **Q:** Do you think that the fact that it is pass/fail changes how much effort you put in? **A:** Definitely. You are trying to just get the lowest possible grade, which is bad, with as little effort as possible. **Q:** What did you expect out of this class? **A:** I thought it was going to be really elementary and it was in the beginning, but now I'm going back and remember this stuff and find it challenging now. This student failed the course.

Interview number 5 was a female subject who demonstrated a poor attitude about mathematics on the initial quantitative survey (44 when the average is 67.45) but scored a 76, 3 points above the average (73), on the arithmetic exam, placing her in bin # 8. Her initial interview showed a lack of confidence and a desire to just get through. A few excerpts from her interviews demonstrate her initial attitude. **Q**: Rating your ability? **A**: "3 or 4". **Q**: Anything else you want to tell me? **A**:"I have one question. On the bottom when it talks about the grade and the final, do I have to take the final? How many points are needed to just pass". This student showed a dramatic increase in confidence at the time of the second interview. Her course grades actually improved as the course work got more difficult. During the second interview she rated her ability a 7 (from a 3 or 4). Her second quantitative survey went up to a (67), which goes along with her new confidence in her ability. She completed all assignments on time and completely and easily passed the course. Her tone and demeanor during the interview displayed a definite liking of her teacher and confidence in her teachers' ability and desire to help her.

Interview number 23 was a male student who had previously taken and failed the workshop during the summer. His initial score on the arithmetic test was a 59/100 placing him in the weaker category of students. His quantitative surveys displayed a better than average attitude (77 and 78) as did both his qualitative interviews. **Q:** How did you end up taking the workshop the second time? Did you fail last time? **A:** ”Yes. Attitude is different than in the morning, than 4:00, and like the evening so everyone else is too, like it’s totally different. My test grades have doubled. Compared to having it at 8:00 in the morning to having it at 4:30”. **Q:** What do you think about the whole concept of the workshop now that you have been through it a couple times? **A**: “I understand its purpose and if I didn’t have it, I know I wouldn’t be prepared since it’s been so long since I’ve had math. Like if I was just thrown into Math 124, I know I would have had to have tutoring sessions every day or something every day because I hadn’t had it for 3 years and the last one I had was just basic cause it’s not a major factor in my major .**Q**: How do you like this class compared to your other college classes? **A**: Great, much better than the first time I took it I think I really need this course”. **Q**: Do you think that this class being pass/fail made a difference the first time versus the second time? **A**:” It makes a difference because I think that when it isn’t worth credit, you don’t try as hard. When you know you are going to get 3 points, it’s going on your transcript, you know someone is going to see it, you try harder—someone’s going to see it. When you know no one is going to see it, you know it will put you behind in the money factor, but if no one is going to see it, you don’t worry about it as much I don’t think”. **Q**: In this particular class, do you feel comfortable now? **A:** “Yes. Ten times more than I did before. This student displayed a positive attitude throughout both interviews. His completion of all assignments on time, coupled with the fact that he did not miss a single class, demonstrates a high degree of motivation. He passed the course by a wide margin.

Interview number 4 was a female non-traditional student. She scored a 50 on the arithmetic test, placing her in bin# 6. She demonstrated a very positive attitude scoring a 90 and a 100 on the quantitative surveys. This was supported by two very positive qualitative interviews. Some excerpts follow**: Q:** Do you think your teacher wants to be there? **A**: I think he likes too much his job. He loved it. He doesn't waste time to make jokes. The only thing he does is math. **Q**: How much are you working compared to your other classes this semester? **A**: It's more work. I don't get credit for it and don't care about the credit. Because I am learning it makes me work more. I know I can do it. **Q**: Anything else you want to tell me? The workshop is useful. **Q**: How did you end up in the workshop? **A**: I took the placement test and I wasn't doing well in math. I wanted the lowest level in math to get a good background. I love the workshop. **Q**: Do you feel pretty comfortable in the class? **A:** Yes, totally comfortable. This student completed every homework assignment and never missed a single class. Even though she started with one of the lowest arithmetic scores, she passed every exam and passed the course.

The next student, interview # 19, is a female student who scored 64 (slightly below average) on the arithmetic test placing her in bin # 7. She initially started the course with a better than average attitude regarding math as demonstrated by her score of 75 on the first quantitative survey. Her initial interview showed a distinct lack of motivation based on the lateness of the class (7 pm). **Q**: How do you feel about the class so far—the atmosphere of it? **A**: I like the teacher. I have the later class at 7:00-8:30 pm. so I just want to get out ASAP. Tired. **Q**: So how do you feel in general about the 7:00 workshop and taking it so late.? **A:** I don't like it so late. When I am in there, I don't concentrate; I am just thinking about getting back to the dorms. **Q:** Is there anything else I should know? **A:** The class is too late! This student completed only 7 of the 12 assignments and failed the last two exams and the final. The second quantitative survey (70) revealed a drop of 5 points in math attitude. During the second interview this student showed responses consistent with the first. She liked the course and teacher but hated the time of the course. She failed the course.

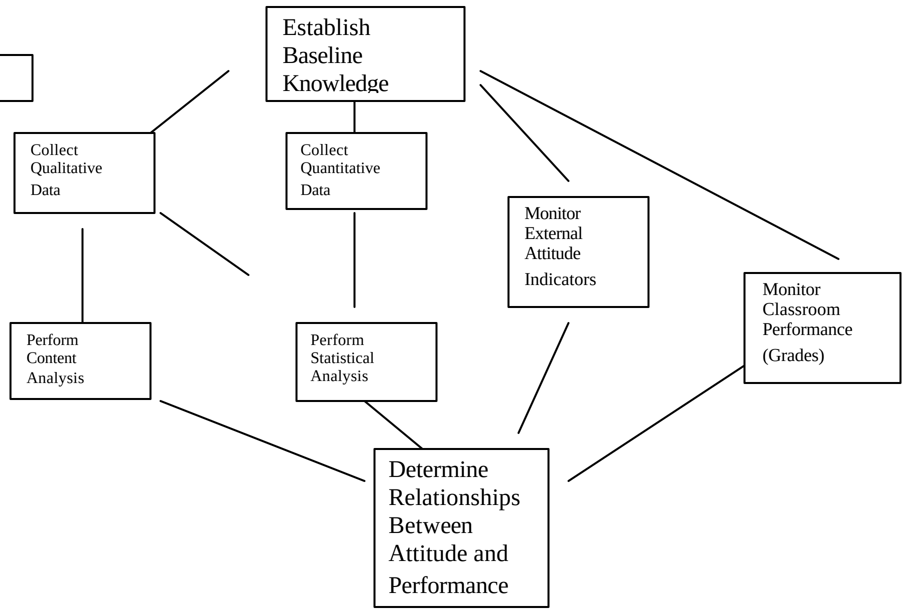
Interview # 21 was a male student who scored a 34 on the arithmetic pre-test placing him in bin # 4. His two quantitative surveys demonstrated a poor attitude about math(scores of 50 and 51, respectively). His observed homework and attendance behavior showed a lack of motivation to succeed, he missed 8 classes of the 39, and earned approximately 50% of the possible homework points, this behavior began on the second day of the course. His qualitative interview showed that lack of motivation is a pattern with this student. **Q:** Math background? **A:** Every year I dig myself in a deep hole, first quarter I get an F or a D, then I dig myself out every year all through high school this has happened to me**:** How did you end up in the workshop? **A:** I don't think my SAT's were good enough. The second time, I missed the …thing so… I just came here. This student liked his class and his teacher: **Q:** How about the classroom environment? **A:** I like my class. The teacher is great he really seems to care'**s:** Do you think your teacher likes teaching? **A:** Oh Yeah. This student failed the course.

The remaining four students interviewed all fit into a single category. All these students were type "a" individuals, who completed the interviews simply because participating was worth extra credit. All four displayed very positive attitudes on both the quantitative and qualitative portions of the study. All liked the class, their particular teacher and were happy for the chance to review their math before it counted on their GPA. A sample of comments which are representative of all four student interviews follow. **A:** Do you think you're good in math? **A:** yes. A's & B's **Q:** Do you do a lot of homework for your math class? **A:** For this math class, it is more looking over notes. **Q:** How did you end up in the workshop? **A:** When we had to take the placement thing, I probably freaked out because I didn't have a calculator so I just basically figured out whatever and I just guessed on everything. **Q:** How do you like your teacher? **A:** Excellent **Q:** What do you think about the reasons behind the workshop? **A:** Good idea. **Q:** Do you like this class better than other classes in college? **A:** Actually, I do. It's entertaining too. All four passed the course.

4.3 MIXED METHOD RESULTS

A mixed methods study is one in which both quantitative and qualitative procedures are employed. The theoretical frame work for this study was to in some measurable way determine each students response to the variables which make up the factors of Affect (ref figure 9).

FIGURE 9



These responses would then be compared to the students level of achievement. Relationships would then, if possible be established between the factors of affect and achievement. It was readily apparent that not all the individual difference variables of Affect could be addressed using a survey instrument, variables such as perceived teacher attitudes toward the class, students comfort level within the class room environment, anxiety levels, beliefs about self, beliefs and the social environment on campus, could better be understood with an interview procedure and time with each student. With a beginning course registration of 193 students is was not possible to interview each student but for this study a sample of 37 of the 193 was obtained.

During the time period in which the quantitative study was active, a qualitative interview protocol was also employed. Two main results came from the qualitative portion of the study. First it was used to triangulate the quantitative survey data. The qualitative study supported the quantitative study by showing the consistency of attitudes when comparisons are made from survey results to interview results with individual students. This served to establish the reliability of the survey questions and methods utilized throughout the study. Another result of the qualitative interview process was that the quantitative survey lacked the ability to explain the underlying reasons behind the observed attitudes. While the quantitative data gave a measure of the students' attitude as a whole, the interview process told the how and the why, of those attitudes. The qualitative protocol showed that the attitudes displayed in the mathematics classroom are not solely based upon mathematics but rather are an aspect of both the subjects preconceived notions about mathematics and the classroom atmosphere.

The interview process revealed to a deeper degree than the survey did, the relevance of two particular variables of Affect , the students preconceived ideas regarding mathematics (beliefs) and the atmosphere of the classroom (which includes interactions within the classroom itself). As seen with students 13 and 34 a negative environment can cause students to not reach their potential while students 4, and 23 showed that a positive experience can help a student reach their potential or beyond. What these four of many student cases demonstrate is that attitudes are changeable either for better or worse. One of the instructors of this course had a far greater failure rate than any other instructor. When the mixed methodology was applied to that section of the course it revealed that the students in that particular setting were influenced by the classroom atmosphere. The negativity revealed during the interviews was also apparent in that their surveyed attitudes dropped as the course progressed. In those class rooms where the students enjoyed a higher success rate, their surveyed attitudes actually increased (got better) as the semester progressed, the interview process also supported this with the positive feeling and attitudes revealed during the interviews..

Another result of the mixed methods was to gain an understanding of the emotions and beliefs associated with a less than the desired amount of effort. It became evident that when a student has a less than desirable attitude it was most discernable in homework and classroom behavior (attendance, attentiveness, ect.). The interviews revealed the learned helplessness predicted within the literature. As educators address attendance and course work issues they must consider the affect of attitude and how the classroom environment is interrelated. The interview process demonstrated that the students who regularly attend classrooms felt comfortable and welcome. Weak students who were placed into course sections which meet very early or very late, missed course work which contributed to attitude issues(poor attitude). These results suggest that the factors of Affect must be considered when creating course policies and in placing students who may be in the lower levels of mathematical abilities.

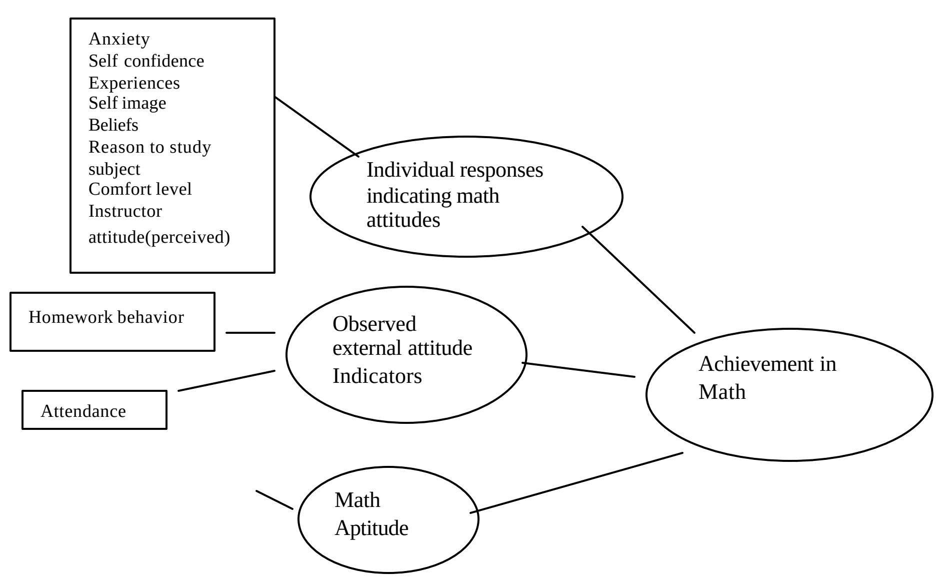
CHAPTER V

5.1 Summary/Conclusions

Many studies on Affect do not have a practical application within the educational environment. The hypotheses presented within this paper and supported by the data gathered within this study, have I believe, a practical application in the development of placement procedures for introductory mathematics courses. Further this study will provide a theoretical frame work for future research.

When consolidating the data from this mixed methods study, it appears that the initial test of this model has produced the desired results. The model is again shown in figure 10 below;

FIGURE 10 : MODIFIED SECOND LANGUAGE MODEL(Mathematics Application)



The main hypothesis or assumption for this study is that there exist various factors which influence a student's achievement in mathematics. Further that these factors are not limited to mathematics aptitude but are rather psychological in nature. Also, that the influence of the individual factors are additive in nature and as such need to be looked at in a simultaneous manner for over all affect.

I had defined earlier that attitude for this study would be defined as: the positive or negative affective responses that are relatively stable. To begin, the reliability of our survey instrument demonstrates for both survey 1 and survey 2, the stability of the student responses. This indicates that the variables chosen for this study represent stable variables of Affect. The reliability analysis results are: for survey 1 alpha = .8672 and for survey 2 alpha = .8750. The Lalonde and Gardner study had an alpha for their attitude section of .63, demonstrating the strength of the reliability of this study's survey instrument.

The second hypothesis was in two parts, the existence of the variables of affect and that those factors would be additive in nature. The design of the survey instrument was such that all the variables of Affect, which the literature had regarded as stable, were incorporated into this single instrument. The values selected by the student for each variable during the survey process were then added together, which resulted in an overall reference number for attitude. If the hypothesis were true, there would exist a relationship between this reference number and the degree of success experienced by the student. The analysis of the data showed that a relationship does exist. In fact; the correlation analysis performed on our data yielded results of a strength previously not seen in the literature. Previous research within math education was conducted using the population as a whole (one single grouping) and reports correlations between achievement and various aspects of attitude no higher than .36. The Lalonde and Gardner study, which was the impetus for this study, yielded correlations, utilizing Pearsons Product moment, between attitude and achievement of.27 to .62, again using the population as one large grouping. Our results for the initial survey administered during the first two days of the course yielded correlations of .54 to .85 (reference table 12) for the lower target groupings of students, again using Pearsons Product Moment. Our second survey yielded even stronger correlations, reference table 13.

The third hypothesis was that these factors of Affect will not influence individuals in a constant manner. Further, that there exists a means to categorize students where the members of a certain category are influenced in similar manner, and that prerequisite math aptitude the student initially brings to that particular course is one way to categorize the students into groups. As described in chapter 4, four grouping schemes based upon an arithmetic pretest was applied. The first scheme was to include all students into one large grouping this resulted in correlations using Pearson product moment of .280 for survey1 and .377 for survey 2, this provided the basis to compare the other schemes. The second scheme separated the students into three grouping by a standard deviation of the mean on the arithmetic test. The results using Pearson product moment ranged from for survey 1 a low of .064 (the upper students) to a high of .389 (the lower students), survey 2 yielded -.054 for the upper students and a .801 for the lower students. Immediately apparent is that the strength of the relationship with the variables is different for different groupings. The third and fourth schemes, (refer to tables 12, 13, 14, 15), yielded even more diverse correlations which were grouping dependent. Thus, this data has shown that prerequisite knowledge or aptitude is useful in separating students into groupings by math aptitude and that different groupings are influenced to varying degree by the factors of Affect.

The results of this study will help mathematics educators address some of the theoretical issues of today and help outline future research on theses same issues. All the classes of variables that have been examined in past research relating mathematics learning (i.e., beliefs, attitudes, emotions, and aptitude) correlated with measures of performance in our introductory algebra course. The present results support the findings of past research in math education such as, Elmore and Vasu (1980), Cooper, Harris, Lindsay, Nye and Greathouse(1998), Schiefele and Csikszentmihalyi 1995, and Brown 1988, to name a few. These studies within mathematics education, however have failed to examine all of the critical variables simultaneously within any type of theoretical framework. Making this study, which looked at the variables simultaneously, of particular interest. The results of this study also support the findings of Lalonde and Gardner(1993) whose study on statistics was the impetus for this study, and which also looked at the variables simultaneously.

The qualitative study provided support for the quantitative survey and at no time did the qualitative and quantitative analysis disagree. The qualitative interviews provided insight to the emotional variables which have not been included in previous math education research in the area of attitude vs. achievement. The qualitative results supported previous qualitative results reported by (Bailey 1983; Horwitz *et al.* 1986; Price 1991; Young 1990), (Tobias 1980).

In addition to demonstrating the potential pattern of relationships among variables in mathematics education, the present results indicate that Gardner's (1979, 1981, 1985) socio-educational model of second language acquisition can be applied profitably to the study of mathematics, although the model was modified to meet the specific needs of the math education application. While Gardner's model for second language acquisition (1979) viewed attitude and aptitude to be independent of each other and the Lalonde , Gardner model for the study of statistics (1993) viewed attitude and aptitude as being negatively correlated, this study demonstrated that (by the various grouping methods employed , using math aptitude), that within particular sub-groups of the population there does exist a positive relationship between aptitude, attitude and achievement, hence the influence which attitude has on achievement varies within the overall population of students. There are indications that this variability is based on prerequisite knowledge. Students with the lowest scores on the arithmetic pretest showed the highest positive correlation between attitude and achievement in this course. Another conclusion is that as shown in earlier studies using standardized tests(ref. section 1.1), and this study using a seventh grade arithmetic test, preexisting math skills/knowledge (math aptitude) is not an accurate predictor within itself of student achievement for those students who score middle to low on prerequisite math tests.

This study also addressed another aspect which has been under researched in math education, that of the stability of the measured variables of affect. In this study we observed an increase in the correlations from attitude survey 1 to attitude survey 2. This phenomenon was hypothesized in the early stages of this project and as such it was decided that correlations would only be run for those participants who took both survey 1 and survey 2. Since students who did not complete both surveys were not included in the correlation analysis, we can conclude that for the groupings where the correlations were strongest, there exists a general trend toward improved measured attitudes over the semester. Interestingly enough, this trend was for the most part limited to those students who had exhibited some amount of success in the course. If this study is to initiate further research to develop a model for predicting student achievement, it is logical that greater attention would be given the initial survey results as the timing of the application of this survey closely approximates a time (as far as initial attitude is concerned) of before the course started, and as such is unaffected by events during the course work itself.

This study also supports the results of Cooper, Harris, Lindsay, Nye and Greathouse(1998), where they reported that homework behavior is directly correlated to achievement in mathematics. However our study incorporated homework behavior as a variable within effort/motivation, and not as a means to mastery of content.

From this study, given the statistical reliability test and the triangulation through the qualitative protocol, we can conclude that in this case the quantitative survey tool proved itself to be a reliable indicator for determining student attitudes a towards mathematics and their mathematics course/class. Further this instrument has the potential, if it is applied in conjunction with an instrument to measure mathematics aptitude, to predict student outcomes in an introductory algebra course.

There are some limitations to the present study which should be considered in terms of the generalizability of the present findings and in terms of future research. While demographics were gathered for each student who participated in this study, gender issues were not addressed. Therefore the influence of gender issues upon the measured variables is unknown. The present study provides only a preliminary test of a model that needs further testing with different samples in order to test its replicability across samples and gender.

5.2 Implications

The results of this study have both theoretical and practical implications for math educators interested in the learning and teaching of mathematics. Some of the theoretical issues can be addressed with our data and certain issues for future research can be outlined.

This correlation analysis within this study has shown that a placement method incorporating both prerequisite math knowledge and attitude would be a more accurate predictor of student achievement for the low to middle level math students than a prerequisite test alone. Further, students who demonstrate non-favorable attitude traits should carefully be placed with those teachers who enhance and encourage. Upper level students could be placed in classrooms where the instructor is not as supportive or attuned to the attitudes in the classroom as higher level students did not have the strong correlation between attitude and success.

One practical implication of this study is the application of intervention programs for those non-math major students who are having difficulty in mathematics. A variety of intervention techniques can be brought into play for those students having difficulty coping with mathematics: reducing the influence of those variables shown to negatively influence attitude(such as class room atmosphere, teacher attitudes, students belief structure), increase mathematical competence, or a combination of these interventions. The results of this study imply that interventions to improve overall attitude would be more affective than programs to improve mathematical competency. It would appear to be unrealistic to expect any remediation program to have a great influence upon mathematical competency over a short time, however this study has shown that measured attitude can be improved over a short time period at least within sub-groups of the population. I would suggest further research to investigate methods to utilize this new model to look at individual instructional practices in an effort to identify those practices which consistently influence student attitude. Once practices which influence attitude are identified, the next logical step would then be to work within teacher education to make educators and policy makers aware of the impact of certain actions and policies, and also to communicate to both students and teachers methods of improving attitude and the learning experience. Mathematics education should follow principles established within second language learning where research has demonstrated that a supportive and emotionally secure learning environment is crucial to those students who struggle with the subject content.

The final and most important implication (at least to this educator) applies not to higher education but to the public sector. Each student comes to an institution of higher learning with a preconceived belief structure. These students have already decided how they feel about mathematics and what their expectations and abilities are. These preconceived notions have been developed within the twelve years of mathematics they experienced in the public schools. Attitudes, in and about the mathematics classroom, are learned behaviors not instinctive behavior. The most far reaching implication of this study is that for low to middle level math students, the attitudes and beliefs about mathematics established within the students first twelve years of education will have a profound and lasting impact upon their achievement in higher education. It then becomes imperative that teachers become aware that the attitudes and beliefs passed on and fostered in the public schools will set the tone for mathematical success or failure the remainder of the students' academic career. It is especially important in the early years where students have one teacher for all subjects. A teacher who themselves may harbor negative feelings about math needs to be especially aware not to pass those attitudes on to their students.

5.3 Future Research

The next stage of this research would be to initiate another study which would apply this theoretical framework to an entire mainstream course which is experiencing high failure rates. If correlations are established as high as were found in this study, then an argument could be made to pilot a new placement procedure based on attitude in combination with prerequisite knowledge.

The next step in this study will be to look at the demographics of the students involved. Although not part of this study, a demographic survey was also administered to each student early on in the semester studied. Further correlation studies need to be run on categories such as state and county of origin, rural versus urban, race, ethnicity and gender. These subcategories in conjunction with the established math pretest will further refine the correlations between attitude and success.

Further research needs to identify specific practices and conditions which result in either positive or negative attitudes. Research has shown that while beliefs are stable and as such, slow to change, emotional issues produce the strongest affect, yet are relatively unstable or subject to change. If researcher could first identify and address those issues which trigger strong emotional responses, this would be a major step in improving attitudes which this study has implied will result in better effort/motivation which will result in a reduction of the high failure rates which initiated this study.

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APPENDIX

RELIABILITY ANALYSIS

A reliability analysis was performed using SPSS 9.0 to determine the internal consistency of the survey administered at the beginning of the course semester. Four variables (Q4, Q23,Q24,Q25) were found to have negative average item total correlations (denoted as $\bar{r}$ in Eqn. 3 above) for the survey as shown below in the following SPSS output.

Table 2: Reliability Analysis

R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q1N	77.7668	108.5547	.4939	.7802
Q2N	77.9275	108.8072	.5500	.7781
Q3N	77.1813	113.9201	.3748	.7874
Q4N	77.9482	124.4244	-.1290	.8106
Q5N	78.3990	106.8244	.5477	.7768
Q6N	78.2280	110.2186	.4929	.7811
Q7N	78.8964	110.7184	.4856	.7817
Q8N	78.8653	109.8047	.4816	.7813
Q9N	77.6425	111.6476	.4364	.7841
Q10N	78.3212	110.1463	.5174	.7802
Q11N	79.3005	108.4821	.5545	.7776
Q12N	78.7824	109.8482	.4992	.7807
Q13N	78.6528	116.6028	.2066	.7952
Q14N	77.5907	109.2743	.4981	.7803
Q15N	78.1347	105.3880	.6267	.7724
Q16N	77.7617	111.7137	.4777	.7827
Q17N	78.0155	114.5050	.3059	.7904
Q18N	78.2487	115.8441	.2331	.7941
Q19N	78.4093	112.7118	.4192	.7853
Q20N	78.8912	118.9933	.1972	.7945
Q21N	78.2124	113.9078	.4413	.7854
Q22N	77.3990	116.8765	.2483	.7929
Q23N	77.5855	122.0252	-.0203	.8042
Q24N	77.5026	124.1680	-.1266	.8067
Q25N	78.1606	136.9689	-.5229	.8366
Q26N	77.3938	116.3545	.2743	.7918

Reliability Coefficients

N of Cases =   193.0   N of Items = 26

Alpha =   .7962

The alpha coefficient for the first survey set of questions was determined to be 0.7962. The four suspect questions were re-examined and determined to be ambiguous in nature. These survey questions (Q4,Q23,Q24,Q25) were excluded from the analysis. Question 25 had the highest negative corrected item-total correlation (-0.5229), indicating the students interpretation of the question differed from the intended measure of attitude. The alpha coefficient for the new data set excluding these questions was calculated as 0.8672. The SPSS output is shown as follows for the new data:

Table 2.1 : Reliability Analysis (Q4,Q23,Q24,Q25 Excluded)

R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q1N	63.9689	125.8324	.4940	.8600
Q2N	64.1295	125.8113	.5619	.8577
Q3N	63.3834	132.0501	.3530	.8646
Q5N	64.6010	123.1681	.5785	.8567
Q6N	64.4301	126.8610	.5253	.8590
Q7N	65.0984	126.9225	.5398	.8586
Q8N	65.0674	125.7506	.5404	.8583
Q9N	63.8446	129.2882	.4304	.8622
Q10N	64.5233	127.0633	.5382	.8586
Q11N	65.5026	125.1367	.5802	.8569
Q12N	64.9845	126.9737	.5094	.8595
Q13N	64.8549	133.5622	.2449	.8684
Q14N	63.7927	126.5297	.5010	.8598
Q15N	64.3368	122.4329	.6258	.8548
Q16N	63.9637	129.1185	.4820	.8606
Q17N	64.2176	131.8586	.3217	.8658
Q18N	64.4508	132.7280	.2717	.8677
Q19N	64.6114	130.0617	.4296	.8623
Q20N	65.0933	136.7517	.2132	.8677
Q21N	64.4145	131.2335	.4586	.8617
Q22N	63.6010	135.3660	.2187	.8683
Q26N	63.5959	134.5025	.2595	.8672

Reliability Coefficients

N of Cases = 193.0   N of Items = 22

Alpha = .8672

A second reliability analysis was also performed on the survey distributed at the end of the course. For this case, two of the same four questions were again found to have negative corrected item-total correlations. These were excluded from the analysis involving the second survey. The number of students taking the second survey (106) was also much lower than the number of students taking the first survey (193). The SPSS output for the reliability analysis with all questions included is shown as follows:

Table 2.2 : Reliability Analysis Survey-2 (All Questions Included)

R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q1N2	75.4434	131.4491	.5641	.8124
Q2N2	75.6321	132.8062	.5366	.8139
Q3N2	74.7830	141.1049	.3620	.8220
Q4N2	75.2736	147.3625	.0949	.8313
Q5N2	75.6132	137.3442	.4154	.8197
Q6N2	75.7075	138.1518	.4265	.8193
Q7N2	76.3302	138.8137	.4236	.8196
Q8N2	76.2925	136.4565	.5128	.8160
Q9N2	74.9623	138.4367	.4470	.8187
Q10N2	75.7642	132.7343	.7074	.8088
Q11N2	76.6887	131.4164	.6396	.8096
Q12N2	76.3774	134.7324	.5687	.8135
Q13N2	76.1698	146.5233	.1100	.8316
Q14N2	75.2736	133.7625	.5715	.8130
Q15N2	75.6321	128.4633	.7115	.8056
Q16N2	75.4434	136.0396	.5065	.8160
Q17N2	75.6981	141.0889	.3643	.8219
Q18N2	75.6509	143.6960	.2103	.8280
Q19N2	75.8113	140.0974	.4018	.8206
Q20N2	76.1038	147.6939	.1204	.8292
Q21N2	75.8208	136.9295	.6173	.8139
Q22N2	74.8868	141.2442	.3434	.8226
Q23N2	75.0849	144.0975	.2272	.8268
Q24N2	74.7830	155.8287	-.3014	.8402
Q25N2	75.2264	170.0435	-.6123	.8642
Q26N2	74.8774	138.8515	.4791	.8180

Reliability Coefficients

N of Cases = 106.0   N of Items = 26

Alpha = .8277

The reliability analysis with the two questions removed from the second survey is shown as follows:

Table 2.3: : Reliability Analysis Survey-2 (Two Questions Removed)

R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q1N2	68.2264	155.2435	.5595	.8665
Q2N2	68.4151	156.1499	.5502	.8668
Q3N2	67.5660	165.7527	.3535	.8727
Q4N2	68.0566	172.3015	.0958	.8792
Q5N2	68.3962	160.9653	.4333	.8707
Q6N2	68.4906	161.3380	.4637	.8697
Q7N2	69.1132	162.2156	.4560	.8699
Q8N2	69.0755	159.7276	.5425	.8674
Q9N2	67.7453	162.9535	.4354	.8705
Q10N2	68.5472	156.4597	.7066	.8630
Q11N2	69.4717	155.0135	.6403	.8639
Q12N2	69.1604	158.4217	.5766	.8663
Q13N2	68.9528	171.1311	.1207	.8793
Q14N2	68.0566	157.6730	.5684	.8664
Q15N2	68.4151	151.4642	.7237	.8608
Q16N2	68.2264	159.7387	.5183	.8680
Q17N2	68.4811	165.4330	.3679	.8723
Q18N2	68.4340	167.2385	.2502	.8759
Q19N2	68.5943	163.9958	.4201	.8709
Q20N2	68.8868	172.2537	.1399	.8770
Q21N2	68.6038	160.7939	.6263	.8661
Q22N2	67.6698	165.7661	.3407	.8731
Q23N2	67.8679	169.3538	.2053	.8766
Q26N2	67.6604	163.4074	.4656	.8698

Reliability Coefficients

N of Cases =   106.0   N of Items = 24

Alpha =   .8750

STATISTICAL METHODOLOGY

RELIABILITY ANALYSIS

Reliability analysis allows an investigation of the internal consistency of the survey instrument. The measurement scale and the questions that comprise the survey are checked for scale reliability. Reliability analysis provides information about the relationships (or correlations) between individual items. Questions that are uncorrelated or negatively correlated with other questions can be identified and can be excluded from the survey or recoded. An overall index of the repeatability of the scales as whole can also be measured using this analysis.

A measurement is considered reliable when it reflects the true score relative to the error. A measure or statistic to describe the reliability of an item or scale is known as an index of reliability. This statistic is the proportion of true score variability captured across respondents relative to the total observed variability and is given in a general form as follows:

$$reliability = \frac{s^2_{score(true)}}{s^2_{score(observed)}} \quad (1)$$

where σ^2_{score} is the variance for the true or observed scores.

ALPHA COEFFICIENT (Cronbach)

Cronbach's alpha coefficient is the most common index of reliability. It is a measure of internal consistency based on the average inter-item correlation. An overall alpha value can be calculated for the entire set of questions as measure of reliability of the survey as a whole. Alpha coefficients range in value from 0 to 1. A high value for the alpha coefficient is an indication of a reliable survey question. Nunnaly has indicated 0.7 to be an acceptable reliability coefficient but lower thresholds are sometimes used in the literature [1]. The equation for calculating the alpha coefficient for the overall survey is as follows:

$$a = \frac{k}{k-1}\left[1 - \frac{\sum s_i^2}{s_p}\right] \qquad (2)$$

or alternatively,

$$a = \frac{k\bar{r}}{1+(k-1)\bar{r}} \qquad (3)$$

where k is the number of individual items, s_i^2 is the variance for each of the k items, s_p is the variance of the total score, and $\bar{r}$ is the average inter-item correlation. The average inter-item correlation is calculated by computing the correlation between items pairwise and then dividing by the total number of pairwise correlations (or more concisely, it is the mean of all the pairwise correlations). When the average inter-item correlation is negative, the question should be reconsidered and either excluded from the analysis or the scale for the question should be recoded.

Refering to Eqn. 2, when the items measure the same variability between subjects (the items measure the true score), the variance of the sum scale will be smaller than the sum of item variances and the alpha coefficient is less than one. If the items are uncorrelated across subjects, the variance of the sum is the same as the sum of variances of the individual items and the alpha coefficient equals zero. If all items are perfectly reliable and measure the true score, then the alpha coefficient equals one.

MEASURE OF ASSOCIATION

Correlations are relationships between two or more variables or sets of variables [2]. Correlations are classified into two basic types: bivariate and multivariate. Bivariate are correlations between two variables and multivariate are correlations between one variable and a set of variables. Three fundamental dimensions to a measure of correlation include direction, magnitude, and significance.

Statistics measuring correlation range in value between –1 and +1. When larger values of X tend to be paired with larger values of Y (or smaller values of X tend to be paired with smaller values of Y), the measure of correlation is close to +1 indicating positive correlation. Conversely, when larger values of X tend to be paired with smaller values of Y (or vice versa), the measure of correlation is close to –1 indicating a negative correlation. When the values of X tend to be paired randomly with values of Y, the measure of correlation is close to zero, X and Y are independent or uncorrelated. Significance tests can also be performed based on the statistics that measure correlation. These allow hypothesis testing to be performed so that statistical inferences can be made about the sample population.

Statistics measuring the correlation between variables can be either distribution dependent or non-parametric (distribution-free) measures. One measure of correlation that depends on the distribution of the two variables is known as Pearson's product moment correlation coefficient. Non-parametric statistics measuring correlation are often based on ranks (for n measurements, the smallest value is assigned rank 1, the largest value is assigned rank n) of the two variables. Examples of these correlations include Kendall's tau and Spearmean's rho correlation coefficients. Monotonicity (a measure of the directional change in the variables) is measured by these coefficients. Non-parametric statistics are beneficial because the distribution of the variables need not be known. These statistics will be discussed in the following sections.

PEARSON PRODUCT MOMENT CORRELATION

Pearson's product moment correlation coefficient, denoted r, is the most commonly used measure of correlation [3]. It is a measure of the strength of linear association between X and Y. This correlation coefficient is computed by the following equation:

$$r = \frac{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)\left(Y_i - \overline{Y}\right)}{\sqrt{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)\sum_{i=1}^{n}\left(Y_i - \overline{Y}\right)}} \quad (4)$$

where, (X_i, Y_i) is each paired observation i = 1,…,n, $\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$ and $\overline{Y} = \frac{\sum_{i=1}^{n} Y_i}{n}$. As mentioned previously, the distribution of r is dependent upon the bivariate distribution of (X,Y), which is unfortunately often unknown. Therefore, the following non-paramteric measures can be used.

SPEARMAN'S Rho

Spearman's rho, denoted ρ, is computed based on a bivariate random sample of size n, (X_1, Y_1), (X_2, Y_2), …., (X_n, Y_n). For tied cases, the average of the ranks that would have been assigned if there had been no ties, are assigned to each tied value. Spearman's rho is actually Pearson's r computed on the ranks of the observations instead of the observations themselves. This statistic is calculated using the following equation:

$$r = \frac{\sum_{i=1}^{n} R(X_i)R(Y_i) - n\left(\frac{n+1}{2}\right)^2}{\left(\sum_{i=1}^{n} R(X_i)^2 - n\left(\frac{n+1}{2}\right)^2\right)^{1/2}\left(\sum_{i=1}^{n} R(Y_i)^2 - n\left(\frac{n+1}{2}\right)^2\right)^{1/2}} \qquad (7)$$

where n is the number of data points, $R(X_i)$ is the rank of X_i for i=1,…,n and $R(Y_i)$ is the rank of Y_i. For example, $R(X_i) = 1$ if X_i is the smallest value of i=1,2, …, n. Significance of this statistic is determined based on a hypothesis test taking the following form:

H_0 : The Xi and Yi are mutually independent (no correlation exists)

H_1: There is a tendency for the larger values of X and Y to be paired together (a positive correlation exists)

The null hypothesis (H_0) is rejected at a significance level of α (the maximum probability of rejecting a true null hypothesis), if $\rho > w_{1-\alpha}$, where $w_{1-\alpha}$ is the quantile of the null distribution (found in Table A10 in Connover [3]). The null distribution is defined as the probability distribution of the test statistic when the null hypothesis is assumed to be true. Significance is indicated by a * in SPSS for a one-tailed test. The p-value is obtained using the following equation:

$$p - value = P\left(Z \geq r\sqrt{n-1)}\right) \tag{8}$$

The p-value is defined as the smallest significance level at which the null hypothesis would be rejected for the given observation.

KENDALL'S TAU

The form of Kendall's tau, which controls for tied ranks is given by:

$$t = \frac{N_d - N_d}{N_d + N_d} \tag{5}$$

where N_c is the total number of concordances, N_d is the total number of discordances. A concordance occurs when both variables change in the same direction. Conversely, a discordance occurs when both variables change in different directions. This version of Kendall's tau is also known as the gamma coefficient. All pairs of (X_i, Y_i) and (X_j, Y_j) with

$X_i \neq X_j$ are compared. Four conditions exist on determining concordance based on the following equation:

$$\frac{Y_j - Y_i}{X_j - X_i} \tag{6}$$

If Eqn. 6 is greater than zero 1 is added to N_c (concordant), if Eqn. 6 is less than zero 1 is added to N_d (discordant), if Eqn. 6 equals zero 0.5 is added to both N_c and N_d, and if X_i=X_j, no comparison is made.

The hypthesis test for the one tailed test is similar to null and alternative hypotheses described above for Spearman's rho.

H_0: X and Y are independent

H_1: Pairs of observations tend to be concordant (a positive correlation exists)

The null hypothesis (H_0) is rejected at a significance level of α if τ is greater than its 1-α quantile in the null distribution (found in Table A11 of Conover [3]),which is indicated by a * or ** in SPSS for a one-tailed test. The p-value is obtained using the following equation:

$$p - value = P\left(Z \geq \frac{(T-1)\sqrt{18}}{\sqrt{n(n-1)(2n+5)}} \right) \tag{7}$$

The letter T here denotes τ used as a test statistic.

MEASUREMENT SCALES

There are three basic types of measurement scales: nominal, ordinal, and interval. The nominal scale uses numbers as codes for representing data properties by separating them into categories or classes. The simplest example of this type is binary data, which is dichotomous and can be coded as 0's and 1's. The numbers assigned to observations function only to divide the data into groups and serve as names for the category, so there is no order associated with the numbers. Ordinal data is in the form of an ordered scale, such as a Likert scale as mentioned previously. Numeric values in this case are used to arrange the elements from smallest to largest. Interval data is considered continuous, where the relative magnitude (or size) is more precise. The focus of this work deals with all three data types: nominal (pass = 1/fail = 0), ordinal (survey scores), and interval (final point scores and arithmetic test scores). Considering these scales, an interval variable may be coded as an ordinal or binary variable using a binning method. Similarly, an ordinal variable may be coded as a binary variable. However, the converse of these statements is not true. Additionally, reducing data to a "lower" scale results in a loss of information and usually a loss of a power associated with a significance test based upon the statistic of interest [3].

SIMPLE LINEAR REGRESSION

Simple linear regression is a model involving only one independent variable (x = predictor variable) and a dependent variable (y = response variable). This model assumes a linear dependence exists between x and y. The model takes the following form:

$$y = a + bx + e \tag{8}$$

in which y is the response variable, x is the predictor variable, α is the y-intercept, β is the slope, and ε is the vertical deviation of a particular point from the line. The regression line then takes the following functional form:

$$f(x) = a + bx \tag{9}$$

The true regression line is approximated using the least-squares method, so that the sum of the square of the differences between actual values of y and the predicted values of y is minimized. The true regression line can be written as follows:

$$\hat{y} = a + bx \tag{10}$$

The sum of the squared deviations around the regression line is:

$$\sum(y-\hat{y})^2 = \sum(y-a-bx)^2 \tag{11}$$

where, $\hat{y}$ is the predicted value of y, a is the estimator of α and b is the estimator of β.

Inferences related to regression line can be made for the parameters α and β [4]. To decide if the model is reasonable, one needs to determine that the line is not horizontal If the line is horizontal, there is no linear relationship between y and x, or x does not make a significant contribution to the prediction of y. The test used for determining if the line is horizontal is as follows:

H_0: β = 0 (the slope is zero; the line is horizontal)

H_1: $\beta \neq 0$ (the slope is not zero;evidence that the line explains a significant portion of the variability in y)

The test statistic used for the test is a t statistics calculated using the following equation:

$$t = \frac{b - b_0}{s_{yx} / \sqrt{S_{xx}}} \quad (12)$$

with $b = S_{xy} / S_{xx}$ and $s_{yx}^2 = (S_{yy} - bS_{xy})/(n-2)$ (13)

and $S_{yy} = \sum y - (\sum y)^2 / n$ and $S_{xy} = \sum (x - \bar{x})(y - \bar{y})$ (14)

where, $\bar{x}$ is the mean of X_i and $\bar{y}$ is the mean of Y_i. The hypothesis H_0 is rejected in favor of H_1 if $|t| > t_{\alpha/2,n-2}$ or $t > t_{\alpha,n-2}$ or $t < -t_{\alpha,n-2}$. A measure of the correlation between the observed y's and the predicted y's ($\hat{y}$'s) is the multiple correlation coefficient, R, and is calculated as follows:

$$R = \frac{\sum (y - \bar{y})(\hat{y} - \bar{y})}{\sqrt{\sum (y - \bar{y})^2 \sum (\hat{y} - \bar{y})^2}} \quad (15)$$

This square of the multiple correlation coefficient, R^2, is the proportion of the variability that has been accounted for by the regression model. Therefore, if the R^2 value is close to 1, the equation fits the data well.The main use of the regression model is prediction, whereas the main use of correlation analysis is measuring the strength of the relationship.

QUALITATIVE INTERVIEWS

Following are the transcribed qualitative interviews:

STUDENT #2 INTERVIEW 1

Q: Tell me about your math background? How long since your last math course
A: two years ago. Calculus

Q: In general, did you like math in high school?
A: No. I hated it.

Q: If you had to rate your ability in math 1-10?
A: 4

Q: What kind of grades did you get in your math classes?
A: A's & B's,
Q: Do you get nervous when you take math tests?
A: Yes.

Q: Do you work more in this class than in others?
A: Usually at the beginning, then at the end I get frustrated and stop doing it.

Q: Why did you end up in workshop?
A: I was forced to.

Q: How do you feel about the workshop so far?
A: I think it is ok.

Q: Do you think it is helping?
A: Some.

Q: So, you felt you needed this?
A: Yes, I did.

Q: Do you feel comfortable in the class?
A: Yes

Q: Do you have friends in class?
A: Yes

Q: What is the next math class you have to take?

A: 126

Q: Do you like your teacher?
A: Yes.

Q: What do you think about this class—general overall—your particular classroom?
A: I think it is beneficial I needed it.

Q: Do you think your teacher enjoys teaching?
A: No

Q: How does this class compare to your other college classes?
A: Just something I have to do.

Q: Whatever your major is, do you think you are going to need math in the future?
A: Don't know.

Q: Anything else you feel strongly about that I should know?
A: A lot of times I sit there and I'm so stressed out about this class and I'm never going to use it. Like I know for a fact I'm never going to have to do this, this, this…you know. Why do I have to be so stressed out about something that is not going to be used……

STUDENT #2 INTERVIEW 2

Q: Tell me about your math background? How long since your last math course?
A: Sr. Yr. – two years ago. Calculus

Q: Did you like calculus?
A: No, I had it in summer school.

Q: In general, did you like math in high school?
A: No. I hated it.

Q: If you had to rate your ability in math 1-10?
A: 3

Q: What kind of grades did you get in your math classes?
A: Freshman and sophomore years I got A's & B's, and then it went downhill from there to D's

Q: Do you really get nervous when you take math tests?
A: Yeah, I generally don't know what's going on.

Q: Do you work at it pretty hard, do you do all the homework?
A: Usually at the beginning, then at the end I get frustrated and stop doing it.

Q: Why did you end up in workshop?
A: I was forced to.

Q: How do you feel about the workshop so far?
A: I think it is good, and goes at a decent pace.

Q: Do you think it is helping?
A: I'm not doing so great in it now so I don't know, but without it, if I just went into….Oh I definitely think it is beneficial to take it.

Q: So, you felt you needed this?
A: Yes, I did.

Q: Do you think that the fact that it is pass/fail changes how much effort you put in?
A: Definitely. You are trying to just get the lowest possible grade, which is bad, with as little effort as possible.

Q: What did you expect out of this class?
A: I thought it was going to be really elementary and it was in the beginning, but now I'm going back and remember this stuff and find it challenging now.

Q: Do you feel comfortable in the class?
A: Yes

Q: Do you have friends in class?
A: Yes

Q: Do you know people here in Morgantown? Do you feel pretty comfortable in town?
A: Yes

Q: What is the next math class you have to take?
A: 126

Q: Do you like your teacher?
A: Yes. Sometimes he is intimidating just because he seems stressed out from his other classes and he seems to come down on us because we are the last class of the day.

Q: What do you think about this class—general overall—your particular classroom?
A: I think it is beneficial, very elementary. I feel the majority of the class aren't traditional students. I know I needed it. Not that I want to be there, but I needed it.

Q: Do you think your teacher enjoys teaching?
A: No

Q: How does this class compare to your other college classes?

A: I kinda feel because it is required to move on, you feel the main focus is not to fully understand all the concepts, but just to get the grade to get out of there and move on to the math you need for your major and stuff.

Q: Whatever your major is, do you think you are going to need math in the future?
A: Depends where I go in my major. I think I'm gonna need some of it, but not a lot of the stuff we are doing.

Q: Anything else you feel strongly about that I should know?
A: No, I can't think of anything.

STUDENT #4 INTERVIEW 1

Q: How long has it been since your last math class?
A: 3 years

Q: What was your last math class?
A: College algebra

Q: If you took college algebra, why are you here taking the workshop?
A: The credit wouldn't transfer in.

Q: Did you like it?
A: Yeah. I liked math. I didn't go through the regular. I went to technical school. Had technical math. I got good grades.

Q: Did you get nervous taking math exams in college?
A: I do. Because I know I'm not going to do well. I'm not confident.

Q: Do you do a lot of homework?
A: I didn't focus a lot on math, I didn't want to waste my time doing problems. I focused on the things I thought I would do well in. In high school, I did a lot of homework because I liked it.

Q: Pass/fail course—does that make a difference on how hard you are working?
A: No. If I thought I was getting a good background…

Q: How did you end up in the workshop?

A: I took the placement test and I wasn't doing well in math. I wanted the lowest level in math to get a good background. I love the workshop.

Q: Do you feel pretty comfortable in the class?
A: Yes, totally comfortable.

Q: Friends in class?
A: No, but I get along with a couple people.

Q: Next math class?
A: 124

Q: Do you like your teacher?
A: Yes.

Q: Do you think your teacher wants to be there?
A: I think he likes too much his job. He loved it. He doesn't waste time to make jokes. The only thing he does is math.
Q: How much are you working compared to your other classes this semester?
A: It's more work. I don't get credit for it and don't care about the credit. Because I am learning it makes me work more. I know I can do it.

Q: Anything else you want to tell me?
A: The workshop is useful.

STUDENT #4 INTERVIEW 2

Q: How long has it been since your last math class?
A: 3 years

Q: What was your last math class?
A: algebra

Q: Did you like it?
A: Yeah. I got good grades.

Q: Did you get nervous taking math exams in college?
A: Yes.

Q: Do you do a lot of homework?
A: I do a lot of homework because I like it.

Q: Pass/fail course—does that make a difference on how hard you are working?

A: No.

Q: How did you end up in the workshop?
A: I took the placement test and failed

Q: Do you feel pretty comfortable in the class?
A: Yes, totally comfortable. I love it.

Q: Friends in class?
A: No.

Q: What is your next math class?
A: Math 124

Q: Do you like your teacher?
A: Yes.

Q: Do you think your teacher wants to be there?
A: Oh YES, he is great.

Q: Compared to your other classes this semester?
A: It's more work. But I am doing it and getting good grades.

Q: Anything else you want to tell me?
A: The workshop is good for people like me who need a review.

STUDENT #5-INTERVIEW 2

Q: How long has it been since your last math class?
A: 2 years

Q: What was your last math class?
A: Trig (HS)

Q: Did you like it?
A: No.

Q: Is that your highest class?
A: Yes.

Q: Rating your ability?

A: 7

Q: What kind of grades in math?
A: B’s & C’s

Q: Did you get nervous taking math exams in college?
A: Yes but I am getting better.

Q: Do you think getting nervous has anything to do with how much homework you do?
A: Yes. —If you don’t do the work there’s no way.

Q: How much homework do you think you are doing for this class?
A; A lot.

Q: More than other classes?
A: Yes

Q: How did you end up in the workshop?
A: Bad act’s

Q: Do you think the workshop is helping you?
A: Yes, a lot .

Q: Do you think you needed it?
A: Yes.

Q: What is your next class?
A: 126

Q: Does pass/fail make a difference on how much effort you put in?
A: I think I would be working harder if there were a grade.

Q: Environment?
A: OK

Q: Friends?
A: Yes.

Q: Friends on campus?
A: Yes.

Q: Do you like your teacher?
A: Yes.

Q: Do you think your teacher likes teaching?
A: Yes.

Q: Do you think he wants to be there?
A: Yes.

Q: Do you agree with the reasons for having the workshop?
A: Yes.

Q: Anything else you want to tell me?
A: no

STUDENT #5-INTERVIEW 1

Q: How long has it been since your last math class?
A: 2 years

Q: What was your last math class?
A: Trig (HS)

Q: Did you like it?
A:No.

Q: Is that your highest class?
A: Yes.

Q: Rating your ability?
A: 3 or 4

Q: What kind of grades in math?
A: B's & C's but I didn't lean anything

Q: Did you get nervous taking math exams in college?
A: Yes. Mostly Math

Q: Do you think getting nervous has anything to do with how much homework you do?
A: I think so. If you don't think you can do it and you go take the test—there's no way.

Q: How much homework do you think you are doing for this class?
A: A lot.

Q: More than other classes?
A: About the same.

Q:How did you end up in the workshop?
A: I kept scoring an 18 on the math section. The last shot I got a 17 and I wasn't improving and it is dragging my overall composite down. It's not worth taking it anymore.

Q:Do you think the workshop is helping you?
A: Yes.

Q: Do you think you needed it?
A: Yes.

Q:What is your next class?
A:126

Q: Does pass/fail make a difference on how much effort you put in?
A: I think I would be working harder if there were a grade.

Q:Environment?
A:OK

Q: Friends?
A: Yes.

Q: Friends on campus?
A: Yes.

Q: Do you like your teacher?
A: Yes.

Q: Do you think your teacher likes teaching?
A: Yes.

Q: Do you think she wants to be there?
A: Some of the time, not all the time.

Q: Do you agree with the reasons for having the workshop?
A: Yes.

Q: Anything else you want to tell me?
A: I have one question. On the bottom when it talks about the grade and the final, do I have to take the final? How many points are needed to just

STUDENT # 9 INTERVIEW #1

Q: How long since your last math class?
A:11th grade.

Q: How high in math have you been in high school?
A: Algebra II

Q: Did you like it?
A: NO

Q: If you had to rate your ability in math from 1 to 10. 10 being the highest, 1 the lowest?
A: 5

Q: Did you get good grades in high school math?
A: No. I will never use this. It doesn't make any sense.

Q: When you take your exams, do you get nervous?
A: No. I would have to care to get nervous

Q: How much effort do you put into this class?
A: Not a whole lot. About the same as my other classes.

Q: How did you end up in the workshop?
A: I don't know. I definitely don't belong here

Q: What do you think about the whole idea of the workshop? Do you think you needed it, didn't need it?
A: No.

Q: This doesn't count for a grade. Do you think that makes a difference?
A: Yeah. It makes me not want to try as hard.

Q: Take the math aside, how do you feel in the class, pretty comfortable?
A: Yeah.

Q: Teachers pretty good?
A: Yeah.

Q: Any friends in the class?
A: No.

Q: Acquaintances in class?
A: Yes, I don't know anyone in the class very well.

Q: Do you know what you have to take for your next math class?
A: 126

Q: Are your teachers OK?
A: Yes.

Q: Do you think he/she likes to be there?
A: Yeah. Sometimes.

Q: In general do you think he likes to teach?
A: Yeah. I think so.

Q: Compared to your other college classes, how do you like this class?
A: It's just about the bottom of the list I would say.

Q: Tell me anything you think I should know about?
A: Yeah, this sucks being in this class, they should just let us go in to the regular class.

STUDENT # 9 INTERVIEW 2

Q: How long since your last math class?
A: 11th grade.

Q: I think I get the impression you don't like math?
A: No.

Q: How high in math have you been in high school?
A: Algebra II

Q: If you had to rate your ability in math from 1 to 10. 10 being the highest, 1 the lowest?
A: 6

Q: Did you get good grades in high school math?
A: No. Cause I don't see a point in it. I saw there is no driving motivation that I am going to use this later in life. It is like I am only using this to get by and graduate. Like that is not enough motivation for me.

Q: Like a hoop you have to jump through?
A: Yeah. It doesn't make any sense. It is the system's idea of what is supposed to be good.

Q: When you take your exams, do you get nervous?
A: No.

Q: How much effort do you put into this class?
A: Not a whole lot, but a good amount, say average. About the same as my other classes.

Q: How did you end up in the workshop?
A: I don't know. When I took the placement exam I was like. Wow, I could be in calculus or something. I thought I knew all the answers. I felt really comfortable after taking it, then…I have no idea how I got in the workshop.

Q: What do you think about the whole idea of the workshop? Do you think you needed it, didn't need it?
A: Yes. I'll admit it, I think I need it, but at the same time I kinda think that I could have just as well gone into Algebra and done the same. I'm still doing office hours sometimes here so I just go down to Algebra II.

Q: This doesn't count for a grade. Do you think that makes a difference?
A: Yeah. It makes me not want to try as hard. I don't like math to begin with and the fact that it doesn't count as credit or a grade, makes less motivation for it.

Q: Take the math aside, how do you feel in the class, pretty comfortable?
A: Yeah.

Q: Teachers pretty good?
A: No

Q: Any friends in the class?
A: No.

Q: Acquaintances?
A: Yes

Q: Do you know what you have to take for your next math class?
A: 126

Q: Are your teachers OK?
A: No.

Q: Do you think he/she likes to be there?
A: No. Sometimes.

Q: In general do you think he likes to teach?
A: Yeah.

Q: Compared to your other college classes, how do you like this class?
A: It's just about the bottom of the list I would say.

Q: Tell me anything you think I should know about?
A: I don't feel like I'm going to be using this necessarily. I have to have it for my major. I just don't feel that I'm necessarily going to need to understand a lot of the problems with math we

have to do. The computer is smarter than me and the computer knows what it is doing more than I do. Like if I just plug it in, if I ever need to know what xy times n squared x n square root what ever, that thing can do it a lot more accurately than I ever could. I feel that there is a lot of math that a human just invented it, like decided that x is going to be this, square root is going to be that, and it all makes sense, but so does the sky being blue and the grass…but we don't make equations out of that, not every day, and it's not in an algebra book. I just doesn't make sense to me that someone just decided that this is that and that is this and now you have to learn it and become completely knowledgeable of it in order to graduate. And, you may not even use it in your career and especially in high school. In high school it just made me horribly mad, because I knew like by the time I was in 9th grade that I would not be incorporating math into my job in the future because it is not what I am interested in, like that side of my brain is not as manageable as the other side of my brain. Like English and history comes so much easier to me. Now I'm a biology major. I'm going to be going into statistics and even now I need to know some math, but as far as statistics and stuff are concerned, I don't really think I need to know like graphs and….I know how to do Excel and stuff. To really be that familiar with numbers and everything, it is just not what I want to do. If I ever need to do that, I'll probably end up getting help down the road anyway. Like, I probably won't be sitting down with my statistics book from my third year of college and figuring out equations, I'll probably get help because by the time I'm 29 or whatever, I'll probably have forgotten a lot of it anyway. I have a lot of anger toward math. If I saw more of a need for it….I think college/high school counselors should allow you to choose what math you want to take and any courses for that matter. If you know by the time you are a junior, you have had enough school to understand what you are interested in and what you are not interested in, I don't think you should be forced to take courses that don't pertain to something that you want to do. Just stress you out more.

I agree that there is a lot of power with it. I feel in my case it involves a lot more stress and I don't want this stress in my life. With all my other classes too, now I have to take this math class…. Is there another way you can come up with that might help people that aren't interested in it to become interested in it?
….I forget stuff, kinda remember. I wouldn't have remembered it unless someone told it to me again so…. when you learn language, you are constantly using it, so if you are constantly talking in xy square, in math lingo, it would be easier to remember, but when you are not using it that much and you forget it, then its like why do I even try to learn it before because I already forgot it now, and it's only been two years or something like that.

Are there other math courses that could possibly be made that would pertain to people in other majors like English majors that would interest them more than…..Algebra 124 or 126.

See what you need to know in your major.

In high school, a lot of my teachers were just there to make money, not to help kids learn.

Good, I'm glad you are doing this.

STUDENT # 13 Interview # 1

Q: How long has it been since your last math class?

A: A year

Q: What was your last math class?
A: Algebra II

Q: Did you like it?
A: Yes, I got a B+, A's in first two marking periods.

Q: If you were going to rate your ability in math from 10 to 1, 10 being the highest, what would your rating be?
A: 6

Q: Did you receive pretty good grades in your high school math?
A: no

Q: Do you get nervous taking tests?
A: Yes

Q: How much homework for this class?
A: Two or three hours more than other classes

Q: How did you end up here?
A: My math SAT was a 430 and I did terrible on the placement test.

Q: What do you think about the workshop in general?
A: I think it is terrible, I don't think it is enough for us because there are reasons we are not in college algebra. I think we deserve more attention than that. Our teacher doesn't go more than 45 minutes everyday and we're supposed to go til 5:30. It's not helping me at all. I'm doing terrible in there right now.

Q: Do you think the pass/fail is part of the reason people don't take it seriously?
A: I think the people take it seriously, but the professor doesn't take it seriously. We go for extra help, and we're told we should already know these things. There are reasons we are not in college algebra, it is remedial. I never did badly in math before. The lowest I got in math was C+, because of the SAT and placement test I am in here and I am doing terrible in this class. I don't understand. We are not getting the attention we need. Things aren't explained how they are supposed to be. Maybe that is because I am a freshmen and I think they need to be explained more, but for me math needs to be explained to the T. I don't hate math, I actually enjoy it, but when it is not taught to me, I get frustrated and I end up thinking I can't do it because I am told when I ask a question in class that I should already know something.

Q: So you actually feel bad in class?
A: Yes. The class is told that when we don't understand something.

Q: What time is your class?
A: 4:00-5:30

Q: Do you think the gender (male/female) makes a difference?
A: No

Q: How do you feel about the class so far—the atmosphere of it?
A: We're told to ask questions, but they are shaken off. We stopped asking questions, because we think we will get yelled at. In class we get a worksheet, a lecture for 10 minutes, she grades the worksheet at home.

Q: Do you have any friends in the class?
A: A couple. We help each other out and stuff.

Q: Social life, friends on campus?
A: I'm from Atlantic City so no one from where I'm from is here, but I've made a lot of friends here.

Q: What is your next course?
A: Math 124

Q: Do you think your teacher wants to be there?
A: No, we've been told she doesn't want to be there.

Q: Do you think she enjoys teaching?
A: Yes.

Q: She just doesn't want to be there??
A: I think that we kinda hold her back, because we're slower than the other classes. I guess she is used to going faster, but I guess it's hard to make a change like where we are.

Q: How do you like this class compared to the other classes, since you are a freshman?
A: Not anywhere close as the other classes.

Q: Anything else you would like to share?
A: No

Interview #13-2

Q: How long has it been since your last math class?
A: A year

Q: What was your last math class?
A: Algebra II

Q: Did you like it?
A: Yes,I did good in it

Q: If you were going to rate your ability in math from 10 to 1, 10 being the highest, what would your rating be?
A: 4

Q: Did you receive pretty good grades in your high school math?
A: C

Q: Do you get nervous taking tests?
A: Yes

Q: How much homework for this class?
A: more than other classes

Q: How did you end up here?
A: I did terrible on the placement test.

Q: What do you think about the workshop in general?
A: I think it is terrible, worse than when we talked before.
the professor doesn't take it seriously Like I told you before this is just a bad teacher

Q: You don't enjoy class at all?
A: No

Q: What time is your class. again?
A: 4:00-5:30

.Q: Do you have any friends in the class?
A: A couple. We help each other out the bad teaching has brought some of us closer,

Q: What is your next course?
A: Math 124

Q: Do you think your teacher wants to be there?
A: No,.

Q: Do you think she enjoys teaching?
A: She just doesn't want to be there

Q: Anything else I should know?
A: This woman should not be teaching if she does not want to be here.

STUDENT #19 INTERVIEW # 1

Q: How long has it been since your last math class?
A: 2 years.

Q: What was your last math class?
A: Geometry

Q: Did you like geometry?
A: Yeah.

Q: How did you feel about your math classes in high school?
A: I just did what I had to do. I didn't like it.

Q: What was the highest level math you did?
A: Geometry.

Q: How did you do Algebra II?
A: good.

Q: So were you a sophomore?
A: Yes.

Q: If you were going to rate your ability in math from 10 to 1, 10 being the highest, what would your rating be?
A: 6

Q: Did you receive pretty good grades in your high school math?
A: Average – B or C

Q: Did you get nervous when you take tests?
A: Yes

Q: How much homework for this class?
A: A lot of homework, I do everything assigned..

Q: Do you think it is more or less than your other classes?
A: Less

Q: Do you think that it is because it is pass/fail?
A: Yes.

Q: How did you end up here?
A: I wanted to be here. I need to review.

Q: Do you feel comfortable in class?

A: We all sit too close..

Q: Do you have friends in the same class?
A: No.

Q: Do you have friends on campus here?
A: Yes.

Q: Do you know what your next math class will be?
A: Probably 126

Q: How do you feel about the class so far—the atmosphere of it?
A: I like the teacher. I have the later class at 7:00-8:30 pm. so I just want to get out ASAP. Tired.

Q: So how do you feel in general about the 7:00 workshop and taking it so late.
A: I don't like it so late. When I am in there, I don't concentrate; I am just thinking about getting back to the dorms.

Q: Is there anything else I should know?
A: The class is too late!

Interview #19-2

Q: How long has it been since your last math class?
A: A couple years.

Q: What was your last math class?
A: Geometry

Q: Did you like geometry?
A: Yeah.

Q: How did you feel about your math classes in high school?
A: I just did it to do it. I really didn't like it.

Q: What was the highest level math you did?
A: Geometry.

Q: Did you take Algebra II?
A: Yeah.

Q: So were you a sophomore?
A: Yes.

Q: If you were going to rate your ability in math from 10 to 1, 10 being the highest, what would your rating be?
A: 5

Q: What kind of grades did you get in your high school math?
A: Average – B or C

Q: Did you get nervous when you take tests?
A: Yes

Q: How much homework for this class?
A: They did a workshop and homework.

Q: Do you think it is more or less than your other classes?
A: Much less

Q: Do you think that it is because it is pass/fail?
A: Yes, definitely.

Q: How did you end up here?
A: I wanted to be here. I needed math anywhere and I didn't want to be stuck in a higher math class.

Q: Do you feel comfortable in class?
A: Just squished.

Q: Do you have friends in the same class?
A: No.

Q: Do you have friends on campus here?
A: Yes.

Q: Do you know what your next math class will be?
A: Probably 126

Q: How do you feel about the class so far—the atmosphere of it?
A: I like the teacher. I have the later class at 7:00-8:30 pm. so I just want to get out ASAP. Tired.

Q: So how do you feel in general about the 7:00 workshop and taking it so late.
A: I don't like it so late. When I am in there, I don't concentrate; I am just thinking about getting back to the dorms.

Q: Is there anything else I should know?
A: Timing of class.