To the Graduate Council:

I am submitting herewith a dissertation written by Kay Irene Meeks entitled "A Comparison of Adult versus Traditional Age Mathematics Students and the Development of Equations for the Prediction of Student Success in Developmental Mathematics at the University of Tennessee - Chattanooga." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

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A COMPARISON OF ADULT VERSUS TRADITIONAL AGE MATHEMATICS STUDENTS AND THE DEVELOPMENT OF EQUATIONS FOR THE PREDICTION OF STUDENT SUCCESS IN DEVELOPMENTAL MATHEMATICS AT THE UNIVERSITY OF TENNESSEE - CHATTANOOGA

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Kay Irene Meeks

December 1989

ABSTRACT

Prediction of college students' successes is important for advisement, placement and admissions purposes. This study was undertaken to determine what differences existed among factors that predict success in mathematics for those students age 25 or older and traditional age college students. These factors included levels of mathematics anxiety, motivation, arithmetic skill, algebra skill, and the amount of college preparatory mathematics.

Data were gathered on 171 students enrolled in Mathematics 105 at the University of Tennessee - Chattanooga during the Fall of 1988. Instruments used included the Mathematics Anxiety Rating Scale, the Survey of Study Habits and Attitudes, and standardized arithmetic and algebra skill tests. Students were separated by age and differences in mean scores for all independent variables, and final course averages were determined. Pearson product-moment correlation matrices were developed to determine intercorrelations among the independent and dependent variables. Stepwise multiple regression was used to develop prediction equations.

Adult students were found to have lower levels of algebra skill, had completed less college preparatory mathematics, had been away from mathematics longer, and had higher levels of mathematics anxiety, motivation and final course averages than younger students.

For traditional age students, arithmetic skill and years of high school mathematics correlated highly with final course averages while these variables and levels of motivation correlated highly with success or failure in Mathematics 105. For adult students, only arithmetic skill correlated with either dependent variable. No prediction equations could be developed for adults. For traditional age students, equations for predicting final course averages and success or failure were based upon arithmetic skill test score and Survey of Study Habits and Attitudes scores, respectively.

It was concluded that adult and traditional age students constitute distinct groups within the college student population, with adult students having weaker entry backgrounds and higher anxiety but also higher motivation and final course averages. Since different variables correlated highly with success or failure for the two groups, admissions and placement decisions should be made separately. Finally, the Survey of Study Habits and Attitudes could be used to identify traditional age students likely to fail Mathematics 105 and consequently need additional study skills training.

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CHAPTER I

INTRODUCTION

The average age of students at The University of Tennessee - Chattanooga, as at most colleges and universities in the United States, is increasing. The National Center for Education Statistics (U.S. Department of Education, 1987) reported that 38% of students enrolled in two and four-year colleges and universities in the fall of 1985 were age 25 or older and projects that by 1995-96 over 48% of students in higher education will be in this age group. In spite of the increasing number of adult students participating in higher education, little is known regarding their characteristics as mathematics students or their performances in mathematics classes. Both the characteristics and performance of adults may be considerably different than that for traditional age college students.

Many students, including most of those age 25 or older, who attend the University of Tennessee - Chattanooga begin their mathematical work in the lowest level Developmental Mathematics course -- Mathematics 105, an introductory algebra course. Successful completion of this course is required before any other mathematics work can be undertaken and all undergraduate degrees offered at the university require at least one college level mathematics course. If it were possible to predict early which students were likely to

succeed and which were likely to encounter troubles with the course, advising or counselling of students would be much easier. This can be particularly important for returning adult students, many of whom tend to lack confidence in their abilities to do college work (Apps, 1981; Pasciullo, 1982), and thus may interpret failure as an indication of inability.

Statement of the Problem

The problem for this study is the scarcity in the understanding of the adult mathematics learner as compared to traditional age students. In particular, it is not currently known whether those factors that predict success in mathematics differ for adult and traditional age students. In addition, it has been suggested by previous research that adult and traditional age students do differ with respect to many of the variables that have been used in developing prediction equations for success. These include level of mathematics anxiety, level of academic motivation, amount of college preparatory mathematics, number of years since the last mathematics course taken, level of arithmetic skill and level of algebraic skill. Consequently, it is unclear whether prediction equations developed based on largely traditional age student populations are valid for adult students or if separate equations should be developed.

Purpose of the Study

The purpose of this study was to compare adult and traditional age students in developmental mathematics in order to answer the question of whether or not they should be treated as distinct groups when making predictions of success. Specifically, the objectives of this study were as follows:

1) To determine whether or not adult students (age 25 or older) differ from traditional age college students with respect to several variables that may influence performance in developmental mathematics, for example, mathematics anxiety, arithmetic skill, amount of high school mathematics, and level of motivation.

2) To establish the relationships of these variables to success in mathematics for both age groups.

3) To compare the correlations of variables established for adult students to those correlations found for traditional age students.

4) To develop prediction equations for the success of traditional age students and for adult students in developmental mathematics.

Rationale

As noted earlier, more adult students are attending colleges and universities and the numbers are expected to continue to rise (Center for Education Statistics, 1987). Several authors have looked at demographic information with respect to adult students in colleges and universities (Anderson and Darkenwald, 1979; Hanson and Lenning, 1973; Iovacchini, Hall and Hengstler, 1985), and a few have considered differences in mathematical abilities between adult and traditional age students (Fredrick, Mishler, and Hogan, 1984; Sewall, 1984). In spite of the differences apparent between these groups of students, most predictive studies have been performed under the assumption that the students under investigation formed a homogenous group, whose success or failure is affected equally by all independent variables studied. Hooper's (1979) study revealed the risks in this approach by noting that when a prediction equation developed in this way was used to predict final course grades of students in a Fundamentals of Algebra course, 75% of the students for whom large positive residuals were found were age 26 or greater. That is, 3/4 of the students for whom the prediction equation did not adequately predict performance were adult students.

The importance of the development of predictive equations for success in college mathematics lies not only in their use for placement purposes, but also in their ability to assist

in identifying those students for whom advisement and counselling on study skills or the difficulty they may face in a course may be useful. A study which tests not only for differences in those variables used to predict success, but also compares the correlations of these variables with success for adult and traditional age students will help resolve the issue of whether or not all college students should be treated as a homogenous group when developing such equations.

Theoretical Framework

Theorist Bernice Neugarten (1979) posed a theory of adult development that stresses there is a normally expected life cycle in which certain events happen. Events that happen off-time from the norm are expected to bring a different response and are likely to be more stressful than those that happen on-time. College attendance in general, or participation in a mathematics course in particular, is an off-time event for the student more than 24 years of age. This may then contribute to low levels of confidence (Apps, 1981; Pasciullo, 1982) and higher levels of mathematics anxiety (Betz, 1978) older students are reported to experience. Using the Fennema and Sherman Math Anxiety Scale, which associated higher scores with more positive attitudes, Betz (1978) found the correlation with age for women in an introductory algebra course to be $-.29$ ($p < .01$) and $-.17$ ($p < .05$) for women in a pre-calculus course.

Adult students also appear to enter college with weaker mathematics skills. Fredrick, Mishler and Hogan (1984) reported students age 25 or older scored significantly lower ($p < .05$) than traditional age students on the mathematics subtest of the Survey of College Achievement, the Metropolitan Achievement Test in Mathematics and on an algebra test. Sewall (1984) also reported significantly different scores on the Metropolitan Achievement Test in Mathematics ($t = 3.20$, $p < .002$).

Both of these factors should lead adult students to perform below traditional age students since both attitude and previous performance are known to correlate with and be effective in predicting mathematics achievement. Specifically, Aiken and Dreger (1961) found mathematics attitude, as measured by the Math Attitude scale, contributed significantly to the prediction of final mathematics grade for female general mathematics students, the t score for significance of regression coefficient 3.16 ($p < .01$). Hendel (1980) found the correlation between MARS scores and scores on an arithmetic test for his study of 69 adult females to be -.53 ($p < .001$), and that mathematics anxiety had the largest R change (.29) of any variable in determining the prediction equation for arithmetic performance. Morgan (1970) and Hooper (1979) both found scores on mathematics achievement tests contributed significantly to prediction equations for success in mathematics courses.

When considering college enrollment however, a self-selection factor enters the picture. Older students are seen as more persistent, that is complete courses more (Anderson and Darkenwald, 1979) and as having different reasons for participating in higher education than traditional age students. Iovacchini, Hall and Hengstler (1985) noted, for example, that older students are less likely to give "Expectation of Others" as a reason for participation than are traditional age students. These differing motivations exhibit themselves in older students having more mature study habits and favorable attitudes toward school (Sewall, 1984) and in studying more hours per week (Iovacchini, Hall and Hengstler, 1985). A positive correlation between attitudes and study skills and success as measured by grade point average has been reported as expected (McCausland and Stewart, 1974).

This difference in motivation and study habits may be a factor which allows adults to overcome initial disadvantages in mathematics skills and anxiety to achieve success in college courses equal to or greater than that of traditional age students. This success is noted by studies which report higher college grade point averages maintained by older students (Hanson and Lenning, 1973). This suggests that those factors which predict success in college mathematics may be different for adult and traditional age students. Hooper's (1979) study further supported this assumption by noting that when a prediction equation developed from combined data of

adult and traditional age students was used to predict final course grades of students in a Fundamentals of Algebra course, 75% of the students for whom large positive residuals were found were age 26 or greater. That is, 3/4 of the students for whom the prediction equation did not adequately predict performance were adult students.

In summary, it is believed that adult students may suffer higher levels of mathematics anxiety than traditional age students since participation in a mathematics course is seen as an off-time event. They also appear to have weaker mathematics preparation than traditional age students. These factors, however, do not appear to correlate with success as strongly for adult students. Instead, adult students counteract these apparent weaknesses with higher levels of motivation, leading to more positive study habits and attitudes that are stronger factors in predicting adults' success. Consequently, if prediction equations for success in introductory college mathematics classes were developed separately for adult and traditional age students, these equations would differ.

Hypotheses

The research hypotheses developed for this study, based on the above theoretical framework were:

H_1: Adult students have significantly higher levels of mathematics anxiety, motivation, arithmetic ability, and

higher final course grade in Mathematics 105 than do traditional age students, as measured by standard instruments.

H_2: There are significant differences in levels of algebraic skill as measured by test score and years of high school mathematics completed between adult and traditional age students, with adults exhibiting lower levels than traditional age students.

H_3: Course grade in Mathematics 105 is negatively correlated with level of anxiety, and with length of time since the last mathematics course for both adult and traditional age students.

H_4: Course grade in Mathematics 105 is positively correlated with level of motivation, with level of arithmetic skill, level of algebraic skill and with amount of high school mathematics completed for both adult and traditional age students.

H_5: The correlations between course grade in Mathematics 105 and each of the three variables: motivation, amount of high school mathematics completed and algebraic skill, are stronger for adult students than for traditional age students.

H_6: The correlations between course grade in Mathematics

105 and each of the variables: anxiety, years since last mathematics course, and level of arithmetic skill, will be weaker for adult students than for traditional age students.

H_7: Prediction equations for course success can be developed for both adult and traditional age students.

Delimitations

This study was delimited to those students at the University of Tennessee - Chattanooga for whom responses on the UTC mathematics placement test resulted in placement into Mathematics 105, Introductory Algebra. The population included those students who had completed no algebra in high school, who had completed one year of high school algebra and had a score below 91% on the arithmetic test, who had completed two years of high school algebra, had a score of less than 48% on the algebra portion of the placement test and had an arithmetic score of less than 72% and finally those students who had completed four years of high school mathematics but who score less than 48% on the algebra and less than 65% on the arithmetic portions of the placement test. These students were those whose precollege mathematics preparation was very weak. The results obtained are thus applicable only to these or very similar populations.

Limitations

Although Mathematics 105 is a multi- sectioned course, taught by three different instructors at the University of Tennessee at Chattanooga, instructor differences was not considered in the analysis. All instructors were full time, regular faculty members and taught from a detailed syllabus, that included a daily lecture schedule. In addition, students used the same course materials and took the same tests in all sections.

Organization of the Study

Chapter II reviews the literature on developmental studies programs, prediction of success in mathematics and age related differences related to this study. Chapter III describes the methods used for collecting and analyzing the data. Also included are definitions of terms and descriptions of the instruments used. Results are given in Chapter IV, followed by discussions of the results, conclusions and implications based on the results and suggestions for further research in Chapter V.

CHAPTER II

LITERATURE REVIEW

Developmental Studies

A recent report by the Southern Regional Education Board noted findings that 36% of first-time entering freshmen at institutions in the board's fifteen member states are in need of remedial or developmental instruction (Abraham, 1988). For four-year liberal arts or comprehensive institutions in the state of Tennessee, the figure is 47.7% (Abraham, 1988). While the report cited does not distinguish between those students needing remedial work in mathematics and those needing remedial work in reading or writing skills, it is reasonable to feel that a large proportion of those students cited do need such instruction in mathematics.

The need for such instruction covers all age and preparation ranges of students entering colleges and universities. In a study of almost 8000 students of various age levels just entering post-secondary institutions, Hanson and Lenning (1973) reported approximately 70% of those age 25 or above expressed a need for help with mathematics skills, as well as nearly two-thirds of those below 25. In a more recent study, Blackburn (1984) reported that almost 48% of students enrolled in developmental mathematics at a major southern university had taken college preparatory mathematics in high school.

The research reported in the literature is not conclusive on the effectiveness of such remedial or developmental work in mathematics. Staley (1984) reported that 21% of those students offered remedial work in mathematics in 1976 at State University of New York at Buffalo had graduated and that the majority of those that had been remediated passed their subsequent pre-calculus course. Using regression-discontinuity techniques, Brown (1987) failed to show that completing a basic algebra course better prepared students for subsequent work at a major university. Finally, Suddick and Collins (1982), based on a study of 200 students with mean age 29 years, reported that those students who did not require remediation in algebra prior to a calculus or statistics course performed significantly better than those requiring prior remediation, but that for the students first completing the algebra course, the grade earned in it correlated positively with the grade in the subsequent course.

One of the stated goals of the Mathematics Department at the University of Tennessee - Chattanooga is to provide developmental work in algebra to those students in need.

Prediction of Success

Prediction of success in college mathematics is important both for placement and counseling or advisement purposes. Several studies have attempted to determine what factors are correlated with success in college mathematics. Others have

attempted to determine prediction equations using cognitive and/or affective variables.

With respect to cognitive variables, those studied most often include scores from standardized achievement tests and grade averages from high school mathematics. Aiken and Dreger (1961), for example, found that the correlation of grade point average from high school mathematics courses and the grade in a college general mathematics course was significant for male students ($t = 4.12$, $p < .01$) but not for females. They also reported significant correlations between scores on the Differential Aptitude Test - Numeric Ability and grade in college general mathematics for both males ($t = 5.09$, $p < .01$) and females ($t = 2.01$, $p < .05$). Adams and Holcomb (1968) found a significant correlation between achievement in a lower level statistics course and both the Educational Testing Service's Basic Skills - Arithmetic test ($r = .42$, $p < .05$) and Algebra test ($r = .35$, $p < .05$).

With students in a community college remedial mathematics course, Edwards (1972) found performance to be correlated with high school grade point average ($r = .29$) and the College Entrance Examination Board's Comparative Guidance and Placement mathematics test ($r = .19$). Corotto (1963) reported success of students in an elementary algebra course at the University of Houston to be correlated with scores on the quantitative scale of the American Council on Educational Psychology Examination of College Freshmen ($r = .31$, $p < .01$) but not with

scores on the Mathematics Screening test developed by the university.

The relationship of scores on the mathematics portion of the Scholastic Aptitude Test with grades in college mathematics has been considered by several researchers. In a study spanning fifteen years, from 1968 to 1983, Gougeon (1984) compared SAT - Mathematics scores and the average of grades earned in all college mathematics courses taken in four years by students. Reported is a low ($r = .284$) but significant ($p < .05$) correlation. Comparing grades earned in an introductory algebra course to SAT - Mathematics scores, Llabre and Suarez (1985) found significant correlations for both male ($r = .318$) and female ($r = .288$) students. In his studies Bridgeman (1982) also found this correlation between SAT - Mathematics scores and grades in an elementary algebra course ($r = .26$), however he reported a significantly stronger ($p < .05$) correlation between algebra grades and scores on the Descriptive Tests of Mathematics Skills - Elementary Algebra test ($r = .47$).

Studies have also been conducted to establish the correlation of demographic and affective variables with success in mathematics. In particular, the length of time since the last mathematics course was taken, attitude toward mathematics and anxiety about mathematics have been considered in relation to achievement in mathematics. Goddard (1971) studied college freshmen, with a characteristic age of 18

years, who had completed eight semesters of college preparatory mathematics in high school and found that those who had participated in mathematics within their last year of high school earned significantly higher grades in their first year college mathematics courses than those who had not taken mathematics during their final year of high school. Hendel (1980) reported significant correlations for both age ($r = -.22$, $p < .05$) and the number of years since last formal mathematics instruction ($r = -.30$, $p < .01$) with scores on an arithmetic test for a group of women in a math anxiety program at a large university.

The results reported concerning attitude toward mathematics and mathematics anxiety are mixed. Aiken and Dreger (1961) reported that scores on their Math Attitude Scale correlated significantly with achievement in a general mathematics course for females but not for male students. Edward (1972) found no significant correlation between attitude toward mathematics and success in remedial level community college mathematics. Using the Revised Math Attitude Scale, Adams and Holcomb (1986) found no correlation between attitude toward mathematics and achievement in lower level statistics, but did find a significant correlation ($r = -.24$, $p < .05$) between achievement and anxiety over mathematics as measured by the Mathematics Anxiety Rating Scale, in which higher scores indicate more anxiety.

Also working with statistics students, Morris, Kellaway

and Smith (1978) found a significant correlation ($r = -.30$, $p < .05$) between scores on the MARS and achievement. They reported finding no significant correlation between anxiety and the grade earned by students in sophomore or junior level mathematics courses however. Llabre and Suarez (1985) reported no correlation between anxiety and achievement of students in an introductory algebra course. Betz reported a significant correlation between scores on the Fennema - Sherman Math Anxiety scale, which equates higher scores with less anxiety, and ACT - mathematics scores for students in both introductory algebra ($r = .22$, $p < .05$) and pre-calculus courses ($r = .34$, $p < .001$). Hendel also reported a significant correlation between anxiety level using MARS scores and arithmetic scores ($r = -.53$, $p < .001$). Studying students admitted to the Developmental Studies program at the University of Georgia, Goolsby, Dwinnell, Higbee and Bretscher (1987) found a significant correlation between first quarter grade in mathematics and mathematics anxiety using the Fennema Sherman scale ($r = .37$, $p < .01$) and between first quarter grade and confidence about mathematics ($r = .35$, $p < .01$).

Motivation has been considered in relation to overall achievement in college, if not specific performance in mathematics classes. Baker and Siryk (1984) reported a significant correlation ($r = .15$, $p < .01$) between first semester college grade point average and scores on their Academic Motivation Scale. Using the Survey of Study Habits and Attitudes,

McCausland and Stewart (1974) also found a correlation between first semester college grade point average and motivation ($r = .40$, $p < .01$).

Determining the best predictor variables to use in developing regression equations to predict student success in mathematics has been the focus of many studies. Morgan (1970) for example used success or failure in an introductory mathematics course at a community college as the criterion variable and developed an equation using, in order of contribution to the prediction, score on the Cooperative Mathematics test from ETS (34%), years of high school mathematics (25%), average grade point in high school mathematics (27%), and age in months past 17th birthday (14%) as the independent variables. The first three correlated positively with success while age correlated negatively. Hooper (1979) found that for a Fundamentals of Algebra course, using course average as the criterion variable, the factors correlating significantly with success were the number of high school mathematics courses taken ($r = .25$, $p < .05$), score on the mathematics placement test given ($r = .58$, $p < .01$), composite score on the ACT ($r = .47$, $p < .01$), and partial and total scores on the Nelson Denny reading test. Case (1984) reported the best predictor variables for performance in entry level mathematics course at a community college to be SAT-Mathematics score, high school grade point average, the product of the number of semesters of mathematics taken in

high school and the average grade in high school mathematics, the number of semesters of mathematics taken in high school and age.

Edwards (1972) included affective variables in the analysis, using an attitude toward mathematics score and a mathematics interest score along with several other variables. Those determined as having the best predictive capabilities were, in order, high school GPA, score on the mathematics portion of the CEEB Comparative Guidance and Placement Battery, attitude toward mathematics score and mathematics interest score.

The use of affective variables in prediction is not unanimously supported in the literature. Aiken and Dreger found mathematics attitude, as measured by the Math Attitude scale, contributed significantly to the prediction of final mathematics grade for female general mathematics students, the t score for significance of regression coefficient 3.16 ($p < .01$). Hendel found the correlation between MARS scores and scores on an arithmetic test for his study of 69 adult females to be -.53 ($p < .001$), and that mathematics anxiety had the largest R change (.29) of any variable in determining the prediction equation for arithmetic performance. Eldersveld and Baughman (1984) also found attitudinal variables useful, and reported the best predictors of success in an elementary algebra course included self reported expectations of performance, time since last mathematics course

was taken, self estimate of ability, and age.

However, Llabre and Suarez, in a study of 184 students in an intermediate algebra course at a private university, found mathematics anxiety, as measured by the Revised Mathematics Anxiety Rating Scale, did not significantly improve prediction for grades for men or women although the two measures were significantly correlated ($r = -.19$). Studying students enrolled in a self-paced, mastery oriented remedial mathematics course, Dahlke (1974) found the best predictors of success included arithmetic skill and age. Scores from the Survey of Study Habits and Attitudes did not contribute significantly to the prediction equation.

Age Differences

Age is seen as related to several of the variables discussed above. Using the Fennema and Sherman Math Anxiety Scale, which associated higher scores with more positive attitudes, Betz (1978) found the correlation with age for women in an introductory algebra course to be $-.29$ ($p < .01$) and $-.17$ ($p < .05$) for women in a pre-calculus course. Hanson and Lenning (1973) reported that more students age 25 and more reported a need for help with mathematics skills than did students age 24 or lower.

Students age 22 or older were found by Iovacchini, Hall and Hengstler (1985) to have different motivations and to study more hours than younger student. In particular, older

students rated "Expectation of Others" lower as a reason for attending college than did younger students, 3.80 vs 3.08 on a scale with 1 = very important and 5 = not at all important. The mean of older students self reports of hours per week studied were 2 to 5 hours greater than those of younger students taking the same number of credit hours. Using relatively small samples, n = 18 for students age 16-24 and n = 45 for students age $\geq$ 25, Sewall (1984) found older students scored slightly higher on the SSHA, means of 120.6 to 108.7, but the differences were not statistically significant.

Adult students appear to enter college with weaker mathematics skills, however. Hanson and Lenning (1973) reported a consistent decline in mean scores on both the Numerical Computation and the Mathematical Reasoning portions of the ACT Career Planning Profile with age. Fredrick, Mishler and Hogan (1984) reported students age 25 or older scored significantly lower ($p < .05$) than traditional age students on the mathematics subtest of the Survey of College Achievement, the Metropolitan Achievement Test in Mathematics and on an algebra test. Sewall (1984) reported students age 25 or more had taken fewer mathematics courses in high school, $\bar{x} = 2.13$ as compared to $\bar{x} = 3.39$ for students age 24 years or less. He also reported significantly different scores on the Metropolitan Achievement Test in Mathematics ($t = 3.20$, $p < .002$) for adult and traditional age students, with adults

scoring lower.

When achievement is considered it appears adult students perform better than do traditional age students. Hanson and Lenning (1973) reported a consistent increase in overall college grade point average across groups of increasing age. Carabin (1982) considered grades earned in a community college entry level mathematics course and found students in the 17 to 21 year age range did poorer than those in the 22 to 41 year ranges, as did those students over 42.

Hooper's (1979) study also pointed to separating students on the basis of age in prediction studies by noting that when a prediction equation developed from combined data of adult and traditional age students was used to predict final course grades of students in a Fundamentals of Algebra course, 75% of the students for whom large positive residuals were found were age 26 or greater. That is, 3/4 of the students for whom the prediction equation did not adequately predict performance were adult students.

Summary of the Literature Review

The literature review suggests that adult and traditional age students differ on many variables associated with success in mathematics. Adults were reported as having weaker mathematical skills, as measured by standardized instruments. Older students were also reported to have lower confidence in their mathematical skills and higher mathematics anxiety as

well as differing motivations and study habits. Finally, adult students have been reported as achieving higher overall college grade point averages and higher grades in entry level community college mathematics.

Several variables, including both academic and affective, have been reported to correlate with success in mathematics. Scores on standardized arithmetic skills or algebra skills examinations were frequently reported to correlate positively with success in entry level mathematics courses, and were suggested by one researcher (Bridgeman, 1982) to be better tools for predicting success in an elementary algebra course than mathematics scores from the SAT. Mathematics anxiety has been reported by several researchers as correlating negatively with success in mathematics, but this correlation is not unanimously supported.

Variables reported as being among the best predictors of success in algebra courses include the amount of high school mathematics taken, scores on standardized mathematical skill tests, attitude toward mathematics or mathematics anxiety and age.

CHAPTER III

METHODS

Definitions of Terms and Variables

The following definitions were used in this study:

1. Adult student: Any student, full or part time, whose age is 25 years or greater.

2. Traditional age student: Any student, full or part time, whose age is less than 25 years.

3. Mathematics anxiety: An extreme, negative, emotional response to mathematics or anything mathematical that may interfere with a person's ability to respond.

The following independent variables were used:

1. Level of Mathematics Anxiety, defined as the score obtained on the Mathematics Anxiety Rating Scale (MARS).

2. Level of Motivation, defined as the score obtained on the Survey of Study Habits and Attitudes (SSHA).

3. Arithmetic Skill, defined as percent score obtained on the Arithmetic Skills test of the Descriptive Tests of Mathematics Skills of the College Board series.

4. Algebra Skill, defined as the percent score obtained on the Mathematics Test BA/1B published by the Mathematical Association of America.

5. Years of High School Mathematics Completed, as determined from student response on the University of Tennessee - Chattanooga mathematics placement questionnaire.

6. Years Since Last Mathematics Course, as determined by student response to questionnaire.

The dependent variable for the study was success in mathematics, as determined by final course average in Mathematics 105 at the University of Tennessee - Chattanooga.

Procedures

Population and Sample

There were 259 students enrolled in Mathematics 105 at the University of Tennessee - Chattanooga in the Fall Semester 1988. All students age 18 years or older who were enrolled for the first time in Mathematics 105 were eligible to be included in the study and were asked to participate. A total of 171 students agreed to participate. Those students repeating the course were eliminated, as well as those under 18 years of age. Sufficient data were collected from 130 students to be included in the analysis. Of these, 36 were adult students and the remaining 94 were traditional age students.

Data Collection

In the first week of classes during Fall Semester 1988, consent forms, which also requested the student's age and the number of years since the last mathematics course was taken, were given to the students. Students were also asked during the first week to complete the Mathematics Anxiety Rating Scale (MARS) and the Survey of Study Habits and Attitudes

(SSHA). All other initial information on the students was accessed through the University of Tennessee - Chattanooga Mathematics Placement testing instruments which included two multiple choice tests, one on arithmetic and one on algebra, and a background questionnaire. All students enrolled in mathematics courses at UTC are required to take the placement test, although a few students in Mathematics 105 do not do so.

The scores earned on nine unit tests, two mid-term comprehensive tests and the final examination in the course were recorded for each student throughout the semester. At the semester's end the course average grade was calculated for each student as the criterion variable. This grade was a weighted average based 30% on the unit test average, 20% on each of the two mid-term comprehensive tests and 30% on the comprehensive final examination. An average of 70% or better was considered as a success while and average below 70% was considered as a failure.

Instrumentation

The MARS is a 98 item scale consisting of sentences describing situations involving mathematics or mathematics course related activities. The student checks a scale from one to five corresponding to how much anxiety would be felt in the described situation. A score from 98 to 490 is obtained with higher scores corresponding to higher levels of mathematics anxiety. The test-retest reliability coefficient of the MARS scale is .85 and the coefficient alpha derived

from a sample of 397 students is .97 (Richardson and Suinn, 1972). Validity as reported by Richardson and Suinn, is based on three studies which showed significant decreases in MARS scores after behavioral therapy for anxiety and from a study which showed the correlation between MARS score and score on the mathematics portion of the Differential Aptitude test was -.64 as expected.

The Survey of Study Habits and Attitudes is a 100 item scale, which is answered on a five point scale denoting how frequently the subject would do or feel as the item indicates. Both positively and negatively keyed items are included. Scoring is accomplished by assigning point values to items answered in a direction indicating a more positive attitude or habit. A score from 0 to 200 is thus obtained with higher scores indicating better study habits and attitudes.

Validity of the Survey of Study Habits and Attitudes, as reported by Brown and Holtzman (1967), is based on studies of freshmen at six colleges. The Survey of Study Habits and Attitudes score was shown to have produced significant correlations with grade point average, r between .25 and .45, and to have produced consistently low correlations, r = .05 to .27, with scores on the American Council on Education Psychological Exam. In addition, the multiple correlations of grade point average with both the aptitude test and SSHA scores were consistently higher than the correlations of grade point average and the aptitude test alone. Thus evidence

exists that the Survey of Study Habits and Attitudes measures traits distinct from aptitude that lead to academic success.

The arithmetic test is the Arithmetic Skills test of the Descriptive Tests of Mathematics Skills of the College Board series. This is a 30 minute, 35 question multiple choice test covering operations with whole numbers, fractions, decimals and percents and application problems involving computation. The algebra test is the Mathematics Test BA/1B of the Mathematical Association of America. Also a 30 minute, multiple choice test, it contains 25 questions of beginning and intermediate algebra. On both the arithmetic and algebra tests, percentage scores of answers correct are obtained.

As Mathematics 105 is a competency based course, multiple equivalent forms of each unit test were used, with retesting required until the student passed at the 80% level. Comprehensive and final examinations were taken only one time. Standardized rules for scoring all tests were followed by graders in the mathematics lab where all tests were taken.

Data Analyses

Data were separated into groups on the basis of student age, those age 18-24 and those age 25 or above, and whether they were enrolled in day sections of Mathematics 105 or the evening section.

After all information had been gathered mean values were computed for arithmetic scores, algebraic scores, mathematics anxiety levels, motivation levels, number of years of high

school mathematics completed, years since last mathematics course taken, and course average for all groups of traditional age and adult students. Two-way analysis of variance procedures were used to compare means for each variable between day and evening, and adult and traditional age students, with a 5% significance level.

Correlation matrices were developed to determine the intercorrelations between the independent variables and the dependent variable for both adult and traditional age students. Also computed were the correlations between all independent variables and the success or failure of students in the course. Significance of correlation coefficients was determined at the 5% level. Stepwise multiple regression was used to develop separate prediction equations for the adult and traditional age students.

All statistical analyses were done using the SPSSx statistical computer package.

CHAPTER IV

RESULTS

Adult and Traditional Age Student Differences

Tables 1 through 14 present the cell means, cell sizes and the results of the analysis of variance for each of the variables. Significance was determined at the .05 level on all tests. All assumptions for the analysis of variance procedures were checked for all variables and were satisfied.

Adult students ($\bar{x}$ = 23.86) were found to be significantly lower, $p < .05$, than traditional age students ($\bar{x}$ = 33.89) in algebra skill and in the amount of high school mathematics completed ($\bar{x}$ = 1.07 versus $\bar{x}$ = 1.78), as seen in tables 4 and 6. They were found to score significantly higher, $p < .05$, in length of time elapsed since the last mathematics course was taken ($\bar{x}$ = 13.11 versus $\bar{x}$ = 1.81), level of mathematics anxiety ($\bar{x}$ = 219.62 versus $\bar{x}$ = 197.70), and level of motivation ($\bar{x}$ = 122.30 versus $\bar{x}$ = 88.50), than traditional age students as seen in tables 8, 10 and 12. Adult students were also found to score significantly higher, $p < .05$, on final course average in Mathematics 105 ($\bar{x}$ = 73.34) than traditional age students ($\bar{x}$ = 59.24) as seen in table 14. No significant differences were found between the groups in arithmetic skill.

The only significant difference found between day and night students was in the length of time since the last mathematics course was taken,($\bar{x}$ = 3.14 years versus $\bar{x}$ = 10.68

TABLE 1

Means and Cell Sizes for Arithmetic Skill Test Scores of Adult and Traditional Age Students

	Day	Night	Total
Traditional age students	71.58 (77)	74.50 (10)	71.92 (87)
Adult students	68.85 (13)	71.27 (15)	70.14 (28)
Total	71.19 (90)	72.56 (25)	

TABLE 2

Results of the Analysis of Variance on Arithmetic Skill Test Scores of Adult vs Traditional Age and Day vs Night Students

Source of Variation	Sum of Squares	DF	Mean Square	F
Main Effects	181.95[a]	2	90.97	.565
Adult/ Traditional	145.17	1	145.16	.902
Day/Night	115.08	1	115.08	.715
Interactions	.96	1	.96	.006
Explained	182.90	3	60.97	.379
Residual	17869.83	111	160.99	
Total	18052.73	114	158.36	

[a] The main effects sum of squares does not partition into the sum of the Adult/Traditional and Day/Night sum of squares due to unequal cell sizes. (See Norusis, page 131)

TABLE 3

Means and Cell Sizes for Algebra Skill Test Scores of Adult and Traditional Age Students

	Day	Night	Total
Traditional age students	34.08 (77)	32.40 (10)	33.89 (87)
Adult students	28.00 (13)	20.27 (15)	23.86 (28)
Total	33.20 (90)	25.12 (25)	

TABLE 4

Results of the Analysis of Variance on Algebra Skill Test Scores of Adult vs Traditional Age and Day vs Night Students

Source of Variation	Sum of Squares	DF	Mean Square	F
Main Effects	2428.60	2	1214.30	8.48*
Adult/ Traditional	1151.26	1	1151.26	8.04*
Day/Night	298.50	1	298.50	2.09
Interactions	142.91	1	142.91	.99
Explained	2571.517	3	857.17	5.99*
Residual	15888.87	111	143.14	
Total	18460.38	114	161.93	

* significant at the .05 level

TABLE 5

Means and Cell Sizes for Years of High School Mathematics Completed by Adult and Traditional Age Students

	Day	Night	Total
Traditional age students	1.83 (77)	1.40 (10)	1.78 (87)
Adult students	1.23 (13)	0.93 (15)	1.07 (28)
Total	1.74 (90)	1.12 (25)	

TABLE 6

Results of the Analysis of Variance on Years of High School Mathematics for Adult vs Traditional Age and Day vs Night Students

Source of Variation	Sum of Squares	DF	Mean Square	F
Main Effects	12.88	2	6.44	8.88*
Adult/ Traditional	5.25	1	5.25	7.24*
Day/Night	2.19	1	2.19	3.02
Interactions	0.07	1	0.07	0.09
Explained	12.95	3	4.32	5.95*
Residual	80.45	111	0.73	
Total	93.39	114	0.82	

* Significant at the .05 level

TABLE 7

Means and Cell Sizes for Years Elapsed Since Last Mathematics Course Taken by Adult and Traditional Age Students

	Day	Night	Total
Traditional age students	1.58 (84)	3.70 (10)	1.81 (94)
Adult students	11.87 (15)	14.00 (21)	13.11 (36)
Total	3.14 (99)	10.68 (31)	

TABLE 8

Results of the Analysis of Variance on Years Since Last Mathematics Course for Adult vs Traditional Age and Day vs Night Students

Source of Variation	Sum of Squares	DF	Mean Square	F
Main Effects	3405.26	2	1702.63	107.7*
Adult/ Traditional	2064.54	1	2064.54	130.6*
Day/Night *	79.86	1	79.86	5.1
Interactions	.00	1	.00	1.0
Explained	3405.26	3	1135.09	71.8*
Residual	1992.25	126	15.81	
Total	5397.51	129	41.84	

* Significant at the .05 level

TABLE 9

Means and Cell Sizes for Level of Mathematics Anxiety of Adult and Traditional Age Students

	Day	Night	Total
Traditional age students	197.81 (73)	196.90 (10)	197.70 (83)
Adult students	229.62 (13)	213.43 (21)	219.62 (34)
Total	202.60 (86)	208.10 (31)	

TABLE 10

Results of the Analysis of Variance on Level of Mathematics Anxiety for Adult vs Traditional Age and Day vs Night Students

Source of Variation	Sum of Squares	DF	Mean Square	F
Main Effects	12719.19	2	6359.59	2.29
Adult/ Traditional	12034.78	1	12034.78	4.33*
Day/Night	1131.23	1	1131.23	0.41
Interactions	979.83	1	979.83	0.35
Explained	13699.02	3	4566.34	1.64
Residual	314170.44	113	2780.27	
Total	32869.45	116	2826.46	

* Significant at the .05 level

TABLE 11

Means and Cell Sizes for Level of Motivation of Adult and Traditional Age Students

	Day	Night	Total
Traditional age students	87.02 (56)	98.88 (8)	88.50 (64)
Adult students	115.20 (10)	125.85 (20)	122.30 (30)
Total	91.29 (66)	118.14 (28)	

TABLE 12

Results of the Analysis of Variance on Level of Motivation for Adult vs Traditional Age and Day vs Night Students

Source of Variation	Sum of Squares	DF	Mean Square	F
Main Effects	25070.26	2	12535.13	13.1*
Adult/ Traditional	10891.98	1	10891.97	11.4*
Day/Night	1735.32	1	1735.32	1.8
Interactions	4.98	1	4.98	0.0
Explained	25075.24	3	8358.41	8.8*
Residual	85924.01	90	954.71	
Total	110999.25	93	1193.54	

* significant at the .05 level

TABLE 13

Means and Cell Sizes for Grade in Mathematics 105 of Adult and Traditional Age Students

	Day	Night	Total
Traditional age students	60.05 (82)	52.60 (10)	59.24 (92)
Adult students	64.00 (11)	78.24 (21)	73.34 (32)
Total	60.52 (93)	69.97 (31)	

TABLE 14

Results of the Analysis of Variance on Grade in Mathematics 105 for Adult vs Traditional Age and Day vs Night Students

Source of Variation	Sum of Squares	DF	Mean Square	F
Main Effects	4805.32	2	2402.66	3.5*
Adult/ Traditional	2728.32	1	2728.32	4.0*
Day/Night	82.09	1	82.09	0.1
Interactions	1875.86	1	1875.86	2.7
Explained	6681.17	3	2227.06	3.2*
Residual	82372.01	120	686.43	
Total	89053.19	123	724.01	

* Significant at the .05 level

years). No significant interaction effects were found for any variable.

While students enrolled in night classes are thus quite similar to students enrolled in day classes, the same cannot be said when comparing adult and traditional age students. These two groups are identifiably distinct, differing on six of the seven variables that were considered in this study. Adult students have weaker algebraic skills when entering, have had fewer years of college preparatory mathematics in high school and have been away from formal mathematics instruction for longer periods of time than traditional age college students. Adult students suffer from higher levels of mathematics anxiety than do traditional age students but also have higher levels of motivation and earn higher grades than traditional age students.

These results support the previous research on variables measuring affective and achievement differences in adult and traditional age students. Research hypothesis H_1 and H_2 noted earlier in this study are thus supported by these results, with the exception of differences in arithmetic skill.

Correlation Analyses

Since day and night students were not found to be distinct groups while adult and traditional age students were, groups were combined without respect to day or night classes and all remaining analyses were performed separately only on

the basis of age. Pearson correlation coefficients were determined for all independent variables and criterion variable final course average. Averages of 70 and above were taken as success in Mathematics 105 and were assigned a value of 1 while averages below 70 were considered as failure and were assigned a value of 0. Point biserial correlation coefficients were then determined for all independent variables with success or failure in Mathematics 105. The correlation matrix for all variables on traditional age students is shown in table 15 and on adult students is shown in table 16. The negative correlations found between arithmetic skill level and algebra skill level or years of high school mathematics completed are due to the placement procedures for students at the University of Tennessee - Chattanooga. These procedures consider the years of high school mathematics taken by the student, the student's scores on the algebra skill and arithmetic skill tests and place students into a course on the basis of this information. The higher a student's algebra skill test score, the lower the arithmetic skill test score needs to be for placement into Mathematics 105.

Course average was correlated significantly with arithmetic skill level ($r = .186$, $p < .05$) and years of high school mathematics taken ($r = .241$, $p < .05$) for traditional age students, while only arithmetic skill level showed a significant correlation with course average ($r = .400$, p

TABLE 15

Intercorrelations of Independent Variables, Course Average and Success or Failure in Mathematics 105 for Traditional Age Students

	Arith. Skill Level	Alg. Skill Level	High School Math	Years Since Last Math	Level of Anxiety	Level of Motivation
Level of Algebra Skill	.202* (87)					
High School Math	-.157 (87)	.082 (87)				
Years Since Last Math	.197* (87)	-.203* (87)	-.090 (87)			
Level of Anxiety	.048 (79)	-.010 (79)	.098 (79)	.034 (83)		
Level of Motivation	.138 (60)	-.086 (60)	.079 (60)	.019 (64)	-.396* (57)	
Final Course Average	.186* (87)	-.059 (87)	.241* (87)	.059 (94)	.065 (83)	.111 (64)
Success/ Failure	.208* (87)	-.006 (87)	.208* (87)	.058 (94)	-.046 (83)	.276* (64)

* Significant at the .05 level

Note: Numbers in parentheses indicate sample size

TABLE 16

Intercorrelations of Independent Variables, Course Average and Success or Failure in Mathematics 105 for Adult Students

	Arith. Skill Level	Alg. Skill Level	High School Math	Years Since Last Math	Level of Anxiety	Level of Motivation
Level of Algebra Skill	-.349* (28)					
High School Math	-.423* (28)	.307 (28)				
Years Since Last Math	-.185 (28)	-.075 (28)	.066 (28)			
Level of Anxiety	.097 (26)	.082 (26)	-.069 (26)	-.030 (34)		
Level of Motivation	-.276 (24)	.065 (24)	.029 (24)	.125 (30)	-.206 (29)	
Final Course Average	.400* (28)	-.003 (28)	.015 (28)	-.050 (36)	-.184 (34)	.053 (30)
Success/ Failure	.405* (28)	-.062 (28)	-.113 (28)	-.017 (36)	-.215 (34)	.053 (30)

* Significant at the .05 level

Note: Numbers in parentheses indicate sample size

< .05) for adult students. Success or failure in Mathematics 105 was significantly correlated with arithmetic skill level ($r = .208$, $p < .05$), years of high school mathematics ($r = .208$, $p < .05$) and level of motivation ($r = .276$, $p < .05$) for traditional age students and only with arithmetic skill level ($r = .405$, $p < .05$) for adult students.

The only independent variable showing a significant correlation with course average for both traditional age and adult students was arithmetic skill level. The correlation coefficient between arithmetic skill and final course average in Mathematics 105 for traditional age students ($r = .186$) and that for adult students ($r = .400$) were compared using Fisher's z_r transformation. The difference between the correlations was not significant ($z = -0.953$, $p > .05$). Similarly, the correlations between arithmetic skill and success or failure in Mathematics 105 for traditional age and adult students ($r = .208$ and $r = .405$ respectively) were compared and were also found not to be significantly different ($z = -1.040$, $p > .05$).

One additional difference in intercorrelations is that of level of mathematics anxiety with level of motivation. For traditional age students only this was a significant negative correlation. That is, traditional age students who showed higher levels of mathematics anxiety also showed lower levels of motivation. There was not a significant correlation here for adult students.

Summarizing, only arithmetic skill level correlated with performance in Mathematics 105 for adult students while the amount of mathematics taken in high school and level of motivation also correlated with success or failure in Mathematics 105 for traditional age students. While these results do not completely support research hypotheses H_3 - H_6, they do show a difference between adult and traditional age students in variables correlating with performance in elementary algebra, using either course average or success or failure as a criterion.

Prediction Equations

Since different variables did show significant correlations with the criterion variables for traditional age and adult students, four stepwise multiple regression procedures were performed. No equations were obtained for adult students, using either course average or success or failure in Mathematics 105 as criterion variable due to the small sample size. For traditional age students, the equation obtained for prediction of final course average in Mathematics 105 was $\hat{y} = .785x + 2.77$ where x is the arithmetic skill test score ($r^2 = .0989$, Beta = .315, $F = 5.928$, $p < .05$). Using success or failure as the criterion variable, the equation developed for traditional age students was $\hat{y} = .0044x + .117$ where x is the score obtained on the Survey of Study Habits and Attitudes ($r^2 = .0791$, Beta = .281, $F = 4.637$, $p < .05$).

These results are in accordance with those of Hooper's (1979) study which found high residuals when equations based on data from both adult and traditional age students were used to predict course grades for adult students.

Summary

The following results were found in the study:

1. There were no statistically significant differences between day and night students in arithmetic skill level, algebra skill level, years of high school mathematics completed, level of mathematics anxiety, level of motivation or grade in Mathematics 105.
2. Adult students scored lower than traditional age students in algebra skill level.
3. Adult students had completed fewer years of college preparatory high school mathematics than traditional age students.
4. More years had passed since the last formal mathematics course for adult students than for traditional age students.
5. Adult students had higher levels of mathematics anxiety, as measured by the Mathematics Anxiety Rating Scale than did traditional age students.
6. Adult students had higher levels of motivation, as measured by the Survey of Study Habits and Attitudes than did traditional age students.

7. Adult students earned higher grades in Mathematics 105 than did traditional age students.
8. There was no significant correlation between final course average in Mathematics 105 and any of the variables algebra skill level, years elapsed since the last mathematics course was taken, level of mathematics anxiety or level of motivation for either adult or traditional age students.
9. For adult students, arithmetic skill level correlated positively with final course average in Mathematics 105.
10. For traditional age students, both arithmetic skill level and years of high school mathematics taken correlated positively with course average in Mathematics 105.
11. There was no significant correlation between the dichotomous variable success or failure in Mathematics 105 and any of the variables algebra skill level, years elapsed since the last mathematics course, or level of mathematics anxiety for either adult or traditional age students.
12. For adult students, arithmetic skill level correlated with the dichotomous variable success or failure in Mathematics 105.
13. No acceptable prediction equations were obtained for adult students using either final course average or success or failure in Mathematics 105 as the criterion variable.

14. For traditional age students, success or failure in Mathematics 105 correlated with arithmetic skill level, years of high school mathematics and level of motivation.

15. For traditional age students, the equation for prediction of final course average in Mathematics 105 was $\hat{y} = .785\ x + 2.77$ where x is the arithmetic skill test score.

16. For traditional age students the equation for the prediction of success or failure in Mathematics 105 was $\hat{y} = .0044x + .117$ where x is the score on the Survey of Study Habits and Attitudes.

CHAPTER V

DISCUSSION OF THE FINDINGS

Conclusions

Several differences were found between adult and traditional age students with respect to the variables of the study. Adult students were found to score lower in algebra skill level, have completed fewer years of college preparatory high school mathematics and have been away from formal mathematics instruction longer than traditional age students. In addition, adult students were found to have significantly higher levels of mathematics anxiety, levels of motivation and final course averages in Mathematics 105 than traditional age students.

There were also differences in correlations between variables for adult and traditional age students. For traditional age students, arithmetic skill level and years of college preparatory high school mathematics correlated positively with final course average in Mathematics 105 while arithmetic skill level, years of high school mathematics and level of motivation show positive correlation with the dichotomous variable success or failure in mathematics 105. For adult students, only arithmetic skill level correlated with either final course average or success or failure in Mathematics 105. In addition, there was a significant negative

correlation between level of mathematics anxiety and level of motivation for traditional age students only.

While no acceptable prediction equations could be developed for adult students, equations were developed for traditional age students. The equation for the prediction of final course average in Mathematics 105 uses arithmetic skill test score for the independent variable and the equation for the prediction of success or failure in Mathematics 105 uses score on the Survey of Study Habits and Attitudes.

On the basis of these results, the following conclusions are drawn from this study:

1. Adult and traditional age students make up two identifiably distinct groups within the population of college students with respect to mathematics skills, motivation and performance.
2. Adult students enter Mathematics 105 with weaker backgrounds and higher anxiety but are more highly motivated and earn higher grades than traditional age students.
3. Different variables correlate positively with the success or failure of adult and traditional age students in Mathematics 105 and thus admission and placement decisions should be made separately for the two groups.
4. The Survey of Study Habits and Attitudes can be used to help identify traditional age students likely to experience failure in Mathematics 105 and indicates a need for study skills training for these students.

Explanation and Discussion of Results

Adult and traditional age students make up two identifiably distinct groups within the population of college students. Separating students on the basis of age resulted in groups which were measurably different on five of six variables used in this study. These include some of the same variables used in many projects interested in predicting success in mathematics. Adult students entered the course with weaker backgrounds and higher anxiety but were also more highly motivated than traditional age students. Adult students also earned higher grades and achieved success in greater proportions than did traditional age students.

The difference in high school preparation is attributable mainly to two factors. First, students attending college immediately after high school are more likely to have planned for this and chosen high school courses accordingly. Many adult students had not planned to attend college and so had not taken college preparatory course work.

Second, traditional age students entering the University of Tennessee - Chattanooga in the fall of 1988 directly from high school came under admissions requirements calling for three years of college preparatory mathematics for regular admission. While conditional admission was possible for students with less than three years high school mathematics, this requirement had been advertised heavily in the local schools in the preceding years. Those traditional age

students who had entered the University as first time freshmen in the few years preceding fall 1988 fell under requirements of one or two years of college preparatory mathematics. Entrance requirements for adult students however, do not include specific course requirements.

Several different explanations are possible for the difference in entering skill in algebra between adult and traditional age students. First and foremost, a much larger proportion of adult students than traditional age students had never had a course in algebra (34% vs 7%, $X^2 = 13.7$, $p < .05$).

A second, lesser, explanation for the difference is the format of the test used to measure algebraic skill. A portion of the mathematics placement test at the University of Tennessee - Chattanooga, the algebra skill test is a timed, 30 minute multiple choice instrument in which students mark responses on computer scan forms. Adult students are likely to be less familiar with this method of testing and often value accuracy over speed and hesitate to guess when uncertain of an answer. For these reasons, the testing format used may have exaggerated actual skill differences between adult and traditional age students.

Adult students were found to have higher levels of motivation than traditional age students. One factor influencing motivation is financial commitment. It is reasonable to feel those with a greater financial commitment to their

education would be more motivated to succeed at it. Adult students are more likely to be paying their own way through school than are traditional age students.

A second factor is the presence of school age children in the homes of many adult students. Students who are parents often feel an obligation to set a good example for their school age children by working hard to obtain the best possible grade in their courses.

Finally, the higher levels of motivation found in adult students may be indicative of the self selective process occurring in college attendance. While the traditional age student is following the expected pattern by attending college, the adult student is attending against societal patterns. As noted by Iovacchini, Hall and Hengstler (1985), adult students are less likely to give "expectation of others" as a reason for college attendance. Those age 25 and over are much more likely to have greater family, home and career commitments than those students 18 to 24 years old and thus only those strongly motivated to attend college and succeed will enroll.

This attendance against societal patterns also contributes to the higher levels of mathematics anxiety found in adult students. In the language of theorist Bernice Neugarten (1979), participation in a college mathematics course is and "off time event" for the students age 25 or over and thus produces a more stressful response.

Additionally, adults are experiencing a fear of the unknown regarding mathematics, since as noted earlier more students age 25 or over had never had an algebra course than is true for traditional age students.

Adult students succeed in Mathematics 105 at a greater rate than traditional age students, 81% to 49% respectively, $X^2 = 10.14$, $p < .01$. In order to discuss the reasons for this difference it is necessary to consider for both groups the correlations with success or failure of the various variables measured.

The only variable to correlate positively with success or failure in Mathematics 105 for both adult and traditional age students was arithmetic skill level. Mathematics 105 contains a brief review of arithmetic skills early in the course, but since it is considered an introductory algebra course, little time is spent on arithmetic. Consequently, those students without strong arithmetic skills have a difficult time succeeding in Mathematics 105.

While arithmetic skill level is the only variable which correlated positively with success or failure in Mathematics 105 for adult students, two additional variables showed significant correlations for traditional age students. These variables are years of college preparatory high school mathematics and level of motivation. The positive correlation between years of college preparatory mathematics taken and success in Mathematics 105 for traditional age students is due

primarily to exposure. Those students who had more previous exposure to algebraic topics and mathematical problem solving skills in high school mathematics classes were more likely to succeed in Mathematics 105.

That exposure rather than the acquisition of skill from these classes is the explanation for the correlation is evidenced by the lack of correlation between algebra skill level and success in Mathematics 105. Further, those students who have acquired significant algebraic skill, as measured by a score of 48% or higher on the algebra skill test given, begin their mathematics at the University in a course beyond Mathematics 105.

The explanation of the positive correlation between high school mathematics and success in Mathematics 105 for traditional age students is not contradicted by the lack of correlation found in these variables for adult students. First, exposure to a topic followed by a several year lapse prior to re-exposure would not be expected to produce the same results as exposure repeated in a shorter time frame. In addition, while the traditional age student is unlikely to have received exposure to algebraic or mathematically related problem solving experiences outside of an academic setting, this is not true for the adult student. The student age 25 or older, with the attendant home and career responsibilities of adulthood, is quite likely to have been exposed to significant mathematical problem solving situations in these environments.

Developing and working with budgets in the home and interpreting and working with financial and numeric data in a work place provide the adult student with exposure to mathematical problem solving if not specific algebraic topics.

The correlation of motivation with success in Mathematics 105 for traditional age students was expected. Those students who scored higher on the Survey of Study Habits and Attitudes would also be expected to study harder, be more diligent in taking unit tests in the course and thus succeed at higher rates. That motivation did not correlate with success in Mathematics 105 got adult students is explained by the significantly higher levels of motivation found in adult students. Very few adult students scored at the lower ends of the Survey of Study Habits and Attitudes scale; the mean score for adults was 122.3 (standard deviation 28.5) while the mean for traditional age students was only 88.5 (standard deviation 31.8).

The last difference in correlations to be considered is that between motivation and anxiety. For traditional age students there was a significant negative correlation between score on the Survey of Study Habits and Attitudes and score on the Mathematics Anxiety Rating Scale. One possible subscale that can be identified on the SSHA instrument is a measure of avoidance, that is, how often does a student delay working on or avoid studying for a course. Traditional age students who are highly anxious over mathematics and mathe-

matics courses also avoid mathematics work whenever possible. Although Mathematics 105 is a required course and thus enrollment is unavoidable, students are to take unit tests on their own schedule. Those traditional age students who are highly afraid of the course avoid taking these tests and thus do not succeed.

This correlation between anxiety level and Survey of Study Habits and Attitudes score was not found for adult students. Instead, adults were frequently overheard remarking that they knew they needed to study harder for this course since they were afraid of it. Their fear seemed to be, in part, a fear of failure and they were aware that hard work would help ensure success instead of failure.

While no acceptable equations for the prediction of success in Mathematics 105 were developed for adult students, an equation was developed for traditional age students. The equation for the prediction of success involved only score on the Survey of Study Habits and Attitudes for traditional age students. For those students 18 to 24 years old whose mathematical skills and backgrounds are sufficiently weak to place them in developmental mathematics, motivation was the factor most important in determining those who would succeed.

Implications Of The Results

Adult and traditional age students make up identifiably distinct groups within the college student population with

respect to mathematics skills, motivation and performance. Different factors correlate with the success or failure of the groups in mathematics. Decisions, then, on admission of students as well as placement in mathematics courses and advisement must be made independently for the two groups.

Many colleges and universities have included completion of specific high school mathematics courses in their entrance requirements. This is done with the recognition that students who have completed these courses may still need remediation, as studies such as Blackburn's (1984) have shown. It is felt that students who have not taken college preparatory mathematics in high school will not succeed in university work even with remediation. The correlation found in this study between years of high school mathematics and success or failure in Mathematics supports this view for traditional age students. Since adult students are succeeding in developmental mathematics in greater proportions and since no correlation was found between their success and high school mathematics preparation, adult students should not be denied admission based on a lack of high school mathematics work.

Placement of students in mathematics courses appropriate to their skill level is a great concern to mathematics faculties. Many departments, like that at the University of Tennessee - Chattanooga, have thus developed placement systems based on ACT or SAT scores, scores on standardized or locally developed skill tests, mathematics backgrounds and other

factors. Since it has been shown that different factors correlate with the success or failure of adult and traditional age students in at least one level of mathematics, departments should examine their systems to be certain that both groups are being adequately placed. It is not sufficient to merely examine overall success rates of students placed in certain courses as this may mask significantly different results for the two groups.

Mathematics departments beginning to develop placement procedures need to include age in their considerations. Age should not be included as a predictor variable, but rather separate equations and placement procedures should be developed for adult and traditional age students.

The correlation of motivation with success in Mathematics 105 for traditional age students should be considered by those planning or in charge of courses structured in a similar way to Mathematics 105 at the University of Tennessee - Chattanooga. Since unit tests for this course are not given on a fixed schedule and since a student who scores below 80 percent on a unit test must complete a homework assignment before retesting on the unit, there is much room for procrastination on the part of an unmotivated student. A more structured version of the course should be developed as an alternative for these students. Students placed into Mathematics 105 on the basis of their mathematical background and skill level, particularly those 18 to 24 years old, should be

tested for level of motivation. Those students who do not exhibit high levels of motivation should be advised to take the more structured option for the course.

Regardless of the structure of developmental mathematics courses, the low scores of traditional age students on the Survey of Study Habits and Attitudes and the correspondingly low success rate of these students indicates instruction on appropriate study techniques would be useful for these students. While instruction of this type will not change the underlying motivation level of the students, it will ensure that they are at least aware of proper study behaviors and habits. Any such instruction offered should not be on an optional basis, but rather presented during regular class meetings or as part of a required special session.

Although the high levels of mathematics anxiety experienced by adult students entering Mathematics 105 did not impede their performance, they should not be ignored. Instructors of adult students should be aware of their anxiety and provide them with positive feedback early in the course. If programs to help students overcome mathematics anxiety are available, adult students should be informed of them. If such programs are not available, consideration should be given to beginning them.

Recommendations

The following recommendations for the University of Tennessee - Chattanooga are made based on the results of this study:

1. The University of Tennessee - Chattanooga should examine its procedures for the placement of adult students in mathematics classes, eliminating, if necessary, consideration of high school mathematics background.
2. All students who place into Mathematics 105 should be given the Survey of Study Habits and Attitudes.
3. A more structured version of Mathematics 105, including a fixed testing schedule, should be developed at the University of Tennessee - Chattanooga. Students who score low on the Survey of Study Habits and Attitudes should be advised or required to take this version of the course.
4. Mandatory study skills training sessions should be included in Mathematics 105 for traditional age students.
5. The mathematics department at the University of Tennessee - Chattanooga should work with the Counseling and Career Planning Center to arrange mathematics anxiety reduction workshops at a time which will allow adult students enrolled in Mathematics 105 to participate.

Suggestions for Future Research

The results of this study indicated that adult and traditional age students who placed into developmental mathematics at the University of Tennessee - Chattanooga differed on several skill and attitudinal variables. In addition, different factors correlated with the success or failure of adult and traditional age students in Mathematics 105 at the University of Tennessee - Chattanooga. One additional study that would seem to be indicated by these results would be to determine if these differences exist in courses above the developmental level. In particular, it would be useful to know if these differences exist in students entering with sufficient skill to begin their mathematics work at the college level.

In particular, future research should be conducted to determine if the low scores observed here for traditional age students on the Survey of Study Habits and Attitudes would be observed for traditional age students starting at higher levels of mathematics work. In addition, some examination of the high school preparation of these students should be undertaken to determine if the attitudes they hold were shaped during their high school mathematics courses. It is possible that these students were never instructed in appropriate study habits and thus mature attitudes and motivations were never developed.

Additionally, if the suggestion made earlier for the

introduction of study skills training for traditional age students is taken, studies would then need to be undertaken to determine the effectiveness of this training. Similarly, if a more structured version of the course were made available a study would need to be conducted to determine if traditional age students did in fact succeed in higher proportions in this version.

The effectiveness of developmental work in colleges and universities is measured by how well it prepares students for subsequent course work. Since adult and traditional age students exhibit significantly different success rates in Mathematics 105, a study that would be worth conducting would be to determine if adult and traditional age students who did complete developmental work succeeded at the same levels in future courses. In other words, are the differences in final course average found in this study between adult and traditional age students also related to differences in the ability to retain and apply mathematical concepts learned to subsequent material.

The significantly different scores on the Survey of Study Habits and Attitudes found for adult and traditional age students and subsequent differences in passing rates also pose the possibility of a difference in the conception of learning possessed by adult and traditional age students. That is, adult and traditional age students may perceive differently what it means to learn or understand mathematical concepts.

If traditional age students do have inadequate perceptions of mathematical understanding, for example that getting the right numeric answer to a problem always indicates understanding, and if these perceptions are related to the success or failure of students in mathematics courses ways need to be found to help students develop more mature perceptions of mathematical understanding. A study that investigates these ideas is thus warranted.

Again, if such differences are found, the background of traditional age students should be examined to determine if their inadequate perceptions were being reinforced during their high school mathematics careers. If grading or testing procedures in secondary schools are reinforcing improper ideas of learning and understanding, an effort would need to be made to train teachers in more appropriate methods of evaluation.

One last area to be considered is that of differences in adult and traditional age learners at the precollege level. In particular, an effort should be made to determine if adult students enrolled in adult basic education or general equivalency diploma completion programs more closely resemble adult students in developmental classes at the college level or traditional age high school students in anxiety, motivation and perception of learning. Training sessions could then be planned to help mathematics instructors in these programs better understand those characteristics of their students which are related to their ability to learn mathematics.

Conclusion

This study has identified several differences between adult and traditional age mathematics learners at the developmental level at the University of Tennessee - Chattanooga. These differences affect both the performance of these students and the prediction of their success for placement or advisement purposes. Although future research needs to be conducted to determine the extent of these differences at other levels of mathematics instruction, the implications of these differences should be considered immediately by those involved in the mathematics instruction of adult and younger students.

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