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Projecting Acceptance Into  
Millersville University's  
Department of Industry and Technology  
Using High School Rank,  
Social Capital, SAT Scores,  
Sex, Age, and Race

by

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(ABSTRACT)

The National Council for Accrediting of Teacher Education (NCATE) revised its standards in 1986. Included in this revision was a new entrance criterion for teacher education units: a 2.5 grade point average (GPA). Research indicated that GPA was not a good measure of aptitude or achievement when it was used to compare students. The large error variance involved in using GPA as a measure of aptitude could eliminate many capable teacher candidates. The researcher determined to create a system which would identify students who would not be likely to achieve the 2.5 GPA and which would also suggest methods for motivated students to increase their chances of achieving the 2.5 GPA. A sample was identified: industry and technology students at Millersville University who were sophomores from the fall of 1981 to the fall of 1986. This sample was randomly divided into two groups for the purpose of cross-validation.

Multiple regression was used for both the overall group and the two subgroups to create equations which predicted sophomore GPA, using the following independent variables: SAT scores, high school rank, age, sex, race and human social capital.

Students who were over 23 years old when they entered the program were eliminated from the study because SAT scores or high school ranks were not available for most of them. Predictors with a significance level of 0.05 had the following squared correlations to sophomore GPA: 1) high school rank: 0.2098, 2) SAT-math: 0.1960, 3) SAT-verbal: 0.1385, 4) special entrance: 0.0566, 5) admission age: 0.0298. Predictors which remained significant when loaded into a multiple prediction equation are listed in order of predictive power with their incremental squared correlation coefficients: 1) high school class rank: 0.2098, 2) SAT-math: 0.0969, 3) admission age: 0.0421, 4) SAT-verbal: 0.0188. The total squared multiple correlation coefficient for the prediction equation was 0.3676. The equation correctly predicted 71.4% of the admission decisions (based on a 2.5 sophomore GPA). Double cross-validation resulted in an average acceptance prediction accuracy of 72.2%. The prediction equation reduced the error of prediction and was recommended for use.

## **ACKNOWLEDGEMENTS**

In all thy ways acknowledge him... Proverbs 3

The researcher gladly acknowledges the enabling power of Jesus Christ.

Among the things one learns from a project of this magnitude is the essential part others play in research. Many people have contributed substantially to making this a tremendous learning experience, and hopefully, a meaningful contribution to the profession.

Charles Pinder, committee chairman, allowed the researcher to talk out many different ideas, and always attempted to effect decisions which were in the best educational interest of the researcher. His suggestions made efficient progress possible.

Some doctoral students view their committees as malicious. The researcher did not have any committee members who were not completely professional. Every suggestion was given with the intention of being helpful.

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## CHAPTER I

### THE PURPOSE

#### BACKGROUND

The recent emphasis on educational reform has led to various outcomes among institutions of higher education. Many of these efforts have originated from outside the specific institution involved. Some have even come from outside the educational community altogether. Many of us in education have found ourselves in the rather uncomfortable position of reacting to reforms rather than creating them.

The researcher was employed at Millersville University in Millersville, Pennsylvania. Millersville's School of Education was undergoing a National Council for Accrediting of Teacher Education (NCATE) evaluation in 1988-89. One of the new NCATE criteria for accreditation was that students not be admitted to the School of Education with less than a 2.5 grade point average (GPA) on a four-point scale. NCATE did not specify a point of admission. Millersville had selected the end of the sophomore year to be the time at which the admission decision was made. The obvious intention of this new criterion was to raise the standards for education majors and thus produce better teachers. The method of achieving this goal could be simply to screen out those students who were lower achievers. National SAT scores show that students intending to major in education have SAT scores about 72 points lower than those planning to

pursue other majors (Grandy, 1987). Clearly the best and brightest students have not flooded into education. Would simply screening out some of the less bright students make room for the more capable students? Without incentives of higher prestige, higher pay, and better working conditions, it was unlikely our brightest college students would fill this void.

Many educational reformers have written about the problems of low teacher salary, low teacher prestige and poor working conditions in education. However, the resulting reforms have placed primary emphasis on artificially created barriers rather than on incentives. Instead of addressing the root cause of the problems (which defied quick fixes) reformers chose to deal with the simpler and more quantifiable. This was accomplished by increased emphasis on assessment--2.5 GPA for admission. It would be easy to argue against this type of band-aid approach to a very complex problem; however, these arguments would serve little purpose. A far better reaction was to use this as an opportunity to produce a better product.

No attempt was made in this study to ratify the emphasis on evaluation suggested by the NCATE criterion. Pemberton (1970) wrote as a result of his research on grading:

(Grades) as measures are ambiguous, reflecting differences in sex, basic temperament, instructors, departments, institutions, as much as levels of competence. And as a predictor of "success," grade point average has not been particularly valid for either graduate school or occupations (p. i).

Another example of the inconsistency of the GPA was shown by the findings of Burnham and Hewitt (1972). They considered the difference in predictive power of high school grades when students came from high schools which used a letter grade-reporting system as opposed to the grades of students who came from schools which used a numerical grade-reporting system (students were about equally split by this criterion). A significant difference was found. As one might expect, the numerical system provided better predictions. This was but one of many differences among grading systems at various schools. It was this type of inconsistency which made GPA only a fair predictor of future grades and a very poor predictor of success beyond college.

Multiple regression was used to develop an equation which would predict, with reasonable accuracy, which students would and which students would not be admitted at the end of their sophomore year if they were required to have at least a 2.5 GPA. Predictors which were used in the analysis were academic ability, high school achievement, maturity, race, sex, and social/human capital.

Predicting the academic success of those entering college has been the purpose of many efforts in education. College admissions officers commonly use a variety of predictors to make admission decisions. The Scholastic Aptitude Test (SAT) was intended to predict students' achievement in college. Crouse (1986) and other researchers have questioned the necessity and even the validity of SAT scores. In reporting his research, Crouse questioned the economic wisdom of using SAT scores

because they add only a small amount of predictive power to other predictors available without paying for a test. However, this researcher believes that since SAT scores were easily available, they provided a meaningful predictor. High school class rank (HSCR) or GPA have proven to be valuable tools for predicting college success. Age and race have been correlated with grades in college. Coleman (1988) popularized the theory of "social capital" as a predictor of school achievement. Social capital involves both the social and financial resources available to a student. The theory purports that a shortage of economic or family resources can be compensated for by appropriate community social resources. The researcher selected the concepts of parental income as represented by the status of financial aid, the number of college activities in which the student intended to participate, inclusion in special admissions programs, and the interaction of these three, to represent the human and social capital a perspective student had at his/her disposal.

Even if this research produced a reasonably accurate predictor of admission and non-admission, several other questions remain to be answered. Where are students having their greatest problems? Can the specific courses which are causing problems be predicted with this or other research? How should students be helped? Perhaps remedial programs in English, math, or science can be used. Do satisfactory remedial programs already exist? Should we modify the courses in the Department of Industry and Technology to include more emphasis on English, math, or science, hoping the students will learn more from the application of academic skills in the laboratory environment?

## **PROBLEM STATEMENT**

The problem of this study was to predict which students would be admitted to Millersville University's School of Education. This required the prediction of a GPA for each student. The central criterion for admission was a minimum 2.5 GPA.

## **STATEMENT OF PURPOSE**

This research created a system which could, upon entrance to the university, identify students who would most likely have difficulty attaining a 2.5 GPA at the end of their sophomore year. A method was devised to predict those who would be admissible to the Department of Industry and Technology at Millersville University and those who were not admissible. This discrimination was made according to the NCATE criterion for admission (2.5 GPA at the end of their sophomore year). Students who entered the university from 1981 to 1986 were used to create a prediction equation which was to be applied to subsequent students. Several independent variables were used for this prediction. These included SAT scores, high school rank, sex, race, human capital and social capital.

## **HYPOTHESES**

### **Overall Hypothesis**

Millersville University's industry and technology students' GPAs can be predicted using a multiple regression equation developed from the following predictors:

1. SAT scores
2. high school rank
3. age
4. financial aid
5. race
6. sex

The following steps were used to evaluate the hypothesis and subhypothesis. First, each predictor was required to meet a .05 level of significance in order to remain in the prediction equation. Second, predictors were dropped from the remaining equation if the cross-validation procedure found that they were not reducing the classification error in predicting whether students would achieve a 2.5 GPA (see Chapter 3 for clarification of the cross-validation procedure).

## Subhypotheses

The exact relationships between variables are listed below:

1. Industry and technology students who had a GPA of 2.5 or above at the end of their sophomore year scored significantly higher on their SAT than those who had a GPA below 2.5.
2. Industry and technology students who had a GPA of 2.5 or above at the end of their sophomore year ranked significantly higher in their high school graduating class than those who had a GPA below 2.5.
3. Industry and technology students who had a GPA of 2.5 or above at the end of their sophomore year had a significantly higher age than those who had a GPA below 2.5.
4. Industry and technology students who had a GPA of 2.5 or above at the end of their sophomore year had parents with a significantly higher income than those who had a GPA below 2.5. This higher income was represented by a lack of need-based financial aid. Students who were successful in achieving the 2.5 GPA also indicated an interest in more activities than the non- successful students. Significantly fewer students who went on to meet the 2.5 GPA criterion had been admitted under a special admissions program than those who did not go on to meet the criterion. The interaction of these three variables also helped predict which students would make the 2.5 GPA.
5. A significantly higher percentage of white industry and technology students had a GPA of 2.5 or above at the end of their sophomore year than industry and technology students of any other race.

6. A significantly higher percentage of female industry and technology students had a GPA of 2.5 or above at the end of their sophomore year than male industry and technology students.

## **RATIONALE**

The sensible response to the new 2.5 GPA requirement for most teacher education units was for those in teacher education to help students do more with the potential they possess. The first logical step in this process was to identify students who needed help in order to make the 2.5 GPA criterion. Such identification was the purpose of this study. A predictive model was created, using data from students who had already completed their sophomore year. This model will be applied to incoming freshmen.

Although many studies have been done to predict college success, this researcher has found no studies which predict acceptance based on a 2.5 GPA. This lack of a study which predicts acceptance based on a 2.5 GPA would not support the need for this study if the great majority of students could be expected to meet the entrance requirement.

Preliminary assessments of student records performed by the department secretary indicated the Department of Industry and Technology could lose approximately 50% of its students if this new standard were enforced. As previously mentioned, the first step in helping those students who might be eliminated was to identify them. Obviously, waiting until they

have taken a few semesters of course work before trying to identify students at risk was not the best method. Using information available at the time the student applies to the university, a reasonably accurate model for predicting failure to meet the 2.5 GPA criterion at the end of the sophomore year was developed by this researcher. The model was to be used to identify at-risk students so that further diagnostic information may be gathered to suggest appropriate remediation.

### **SIGNIFICANCE OF THE STUDY**

The direct result of this study was to provide the first step (a predictive model) in a remediation system. This model was intended to identify students who were not likely to achieve a 2.5 GPA by the end of their sophomore year. These students could then be given appropriate assistance to improve their chances of obtaining a 2.5 GPA.

This study did not provide a prediction equation which will work in other situations. However, it should provide a model for constructing such an equation within the context of the situation in question.

### **ASSUMPTIONS/LIMITATIONS**

#### **Assumptions**

The major assumption of this study, as with all predictive research, was that the future can be projected using the past as an example. Here

statistical techniques were used to create a prediction and also to estimate how accurate that prediction would be once it was used. Obviously, this sort of scientific soothsaying was based on the assumption that students enrolled in the program at the time the study was conducted were very much like those students who would enroll in the future. This may seem to be a risky assumption. However, the cross-validation procedure (see Chapter III) was designed to answer this concern. This cross-validation also dealt with students who had already completed their sophomore year; after all, evaluation of students who have not yet enrolled would not be possible.

Several assumptions were also accepted as a result of the statistical analysis. The following is a list of the three basic assumptions which must be considered when using multiple regression (adapted from Lewis-Beck, 1980, p.26):

1. No specification error.
  - a. The relationship between dependent and independent variables is linear.
  - b. No relevant independent variables have been excluded.
  - c. No irrelevant independent variables have been included.
2. No measurement error: The independent and dependent variables are accurately measured.
3. The following assumptions concern the error:
  - a. Zero mean: For each observation, the expected value of the error term is zero.

- b. Homoskedasticity: The variance of the error term is constant for all values of the independent variable.
- c. No autocorrelation: The error terms are uncorrelated.
- d. The independent variable is uncorrelated with the error term.
- e. Normality: The error term is normally distributed.

### Limitations

The prediction equation created in this study was limited to industry and technology students (specifically industrial arts/technology education students) at Millersville University. It seems reasonable to expect that requiring students to have a 2.5 GPA might change their GPA. Students could work harder. Faculty could grade differently. Therefore, the maximum validity of the equation can only be obtained if the equation is updated after the first year. Therefore, the only valid inference for the equation created by this analysis would be to those students entering Millersville University's industrial arts division of the Department of Industry and Technology in the fall of 1989.

Predictor variables in this study were deliberately limited to student information available on the Millersville computer system. This was a calculated effort on the part of the researcher to make the results of the study more practical. Once this research had produced a prediction equation, the goal was to apply this equation to entering freshmen. Data collected from individual student transcripts, although time consuming, would have been possible for this study. However, expecting advisors to

research each student's records was unrealistic. Limiting the predictor variables to data available through the student data base greatly increased the likelihood that the subsequent system would not be so labor intensive that it would not be practical.

### **CONCATENATED THEORY OF COLLEGE ADMISSION**

The researcher's prediction of the relationship between the concepts involved in academic achievement are listed in Figure 1 on page 13.

A brief explanation of each of the concepts utilized in Figure 1 on page 13 is included here:

1. Academic potential: the ability to succeed at college-level academic work.
2. Maturity: the clarity of personal educational goals, motivation to succeed, ability to overcome obstacles to learning/achievement.
3. Human capital: the impact of other individuals in the life of the student. This frequently involves the student's parents. Examples include parental income level, parental educational level, the amount of time a parent invests in showing interest in a child's education.
4. Social capital: the impact of the social environment upon one's educational achievement. Examples include the amount of importance one's social group places on education, the average educational level of one's social group, the interest this social group places in those involved in education.

AP

M

HC

A

SC

HSA

R

Sex

AP = Academic Potential

M = Maturity

HC = Human Capital

SC = Social Capital

HSA = High School Achievement

R = Race

Sex

A = Achievement in College

Figure 1. Theory predicting admission to the department of industry and technology: This is a graphic representation of the researcher's beliefs, before this study was conducted, about how the concepts involved in this prediction were related.

5. High school achievement: the academic achievement of the student relative to other students at the same school.
6. Achievement in college: the predicted academic achievement of the student in college.

### **TEST MODEL OF COLLEGE ADMISSION**

The model listed in Figure 2 on page 15 further defines the concepts in Figure 1 on page 13. The concatenated theory shown in Figure 1 on page 13 represents the constructs the researcher has chosen to predict admission and shows the relationships among these constructs. The model in Figure 2 on page 15 shows the operational definitions for these constructs. The operational definitions are placed in the same relative positions as the constructs to which they correspond in the concatenated theory.

### **SUMMARY**

The educational historians of the future may well record the 1980s as a period of "educational reform" in the United States. Among the reforms to have the greatest potential impact upon higher education in the United States was the NCATE criterion that students have a 2.5 GPA in order to be admitted to a School of Education. The intention of this reform was to improve the quality of education at all grade levels by producing higher quality teachers.

SAT

Age

FA, ACT, SP

INT

GPA

HSR

R

Sex

Academic Potential = SAT = SAT math and SAT verbal scores

Maturity = Age = Age at time of admission

Human Capital = FA, ACT, SP = FA was a dichotomous variable:  
receiving need-based financial aid or  
not receiving such aid

ACT was the number of activities the student  
planned to participate in during college

SP was a dichotomous variable, admitted  
under a special program (PACES or June-  
January) or not admitted under a special  
program

Social Capital = INT = INT interaction among FA, ACT, SP

High School Achievement = HSR = High School Rank (percentile)

Race = R = Race; dichotomous variable: white or nonwhite

Sex = Sex = male or female

Achievement in College = GPA = mean grade point average (4.0 =  
A) taken at the end of the sophomore year

Figure 2. Model for testing the theory of admission to the Department of Industry and Technology: These are the operational definitions for the concepts listed in Figure 1 on page 13. Note that the concepts are listed before each operational definition for clarity.

Despite the clear evidence in the research that GPA does not provide a good measure of either achievement or aptitude, especially if the purpose is the comparison of students, NCATE persisted in utilizing GPA as a method of improving education. The error inherent in using the GPA as a measure of achievement and/or aptitude guaranteed that many capable students would be eliminated by the 2.5 GPA entrance requirement.

This 2.5 GPA entrance criterion could eliminate approximately half the students in Millersville University's Department of Industry and Technology. Although this screening effect may be the exact intent of the reform, the researcher believes the better alternative is to help capable and motivated perform better, meet the standard, and eventually become better teachers.

The researcher intended to identify those students who would most likely not meet the 2.5 GPA entrance criterion and to suggest a strategy which would increase their chances of successfully entering the School of Education. It was not the intention of the researcher to circumvent the NCATE entrance requirement. The goal was to help students in jeopardy identify what efforts they should make to improve their chances of meeting the requirement. This identification process was the focus of this study.

Multiple regression was used to develop an equation which would predict, with reasonable accuracy, which students would and which students would not be admitted at the end of their sophomore year if they were required to have at least a 2.5 GPA. These predictions were based upon the stu-

dents who are currently enrolled at Millersville University in the Department of Industry and Technology. A cross-validation process was used to test the validity of the prediction equation. This equation would eventually be applied to entering freshmen in order to identify students who are at risk of not achieving a 2.5 GPA. Predictors which were used in the analysis were academic potential, high school achievement, maturity, race, sex, and social/human capital.

The results of this research should have an immediate effect upon the students entering the Department of Industry and Technology at Millersville University. They should be better equipped to meet the 2.5 GPA requirement, because those who are most at risk of not achieving this goal would be identified and remediation would be suggested. The prediction equation developed in this study will not apply to situations or times other than the fall semester of 1989. However, it may provide a model for developing a prediction equation which will be valid in other situations at other times.

## CHAPTER II

### REVIEW OF RELATED LITERATURE AND RESEARCH

In this chapter the researcher reviews the origins of the problem and explains how the solution to the problem would contribute to knowledge in the field of technology education. Research in the area of predicting college success is plentiful. A summary of pertinent studies in this area is included. The researcher also reviews the research supporting the inclusion of each variable and attempts to rank the predictive power of each of the variables.

#### ORIGINS OF THE PROBLEM

Did terms like "a rising tide of mediocrity" or "a conspiracy within" reflect the existing mood toward educational reform or create a mood conducive of that reform? Probably both. Phipps (1986) pointed out that the National Commission on Excellence in Education's call for educational reform in a A Nation at Risk and the subsequent avalanche of other panels, commissions and reports did not start the educational reform, but they certainly affected it. He identified the theme of this movement as "more rigorous standards for students and more recognition and higher standards for teachers"(1986, p.k1). Gardner (1986) asserted that the education reports did not create the national concern about education; rather, the reports grew out of existing concern about education. Most of these reports stressed a balanced approach for reform. Logically, this approach

would include raising standards while increasing the support necessary to meet the new standards.

Perhaps the educational community had waited too long to overcome its own inability to identify and cope with the need for reform. Politicians quickly identified the advantage of being viewed as an "educational reformer," one who was involved in "tightening the low standards of the '70s." The President and many governors quickly adopted education as a "number one priority." The balance between creating new assessment goals and providing new resources fell heavily in favor of assessment. This process of increased emphasis on assessment as the primary reform, while failing to provide a substantial increase in the allocation of resources, became an increasingly important and consistent theme of the educational reform movement.

Considering this mood toward educational reform, it was little wonder that NCATE would reform the national accreditation process for teacher education. It was also no surprise that these changes would include the use of assessment as a major method of improving education. Roots of the reforms of NCATE reach further into the past than 1983 and the publication of A Nation at Risk. Gollinick and Kunkel, officials of NCATE, explained the reform of NCATE as a response to "national attention (being) focused on the relationship between high quality teacher preparation and excellent schools"(1986, p.310), an obvious reference to the A Nation at Risk mania. However, Gollinick and Kunkel also detailed three direct calls for reform of their organization in 1976, 1980 and 1983. These calls for

reform came respectively from deans of land grant universities and colleges, the Institute for Research on Teaching at Michigan State University, and the American Association of Colleges for Teacher Education. These three efforts represented a perceived need to reform the accreditation of teacher education before 1983. The reforms proposed by the reports which predated A Nation at Risk would probably not have resulted in the emphasis on student assessment that the eventual document did. This emphasis on improving all of education by raising the standard for prospective teachers resulted when a reform movement already in motion was met by a "national mood toward improving standards."

The NCATE revision which eventually resulted divided standards into five categories: knowledge base for the profession, relationship to the world of practice, students, faculty and governance, and resources. Among the standard for students: "To be admitted to a professional education unit, a student must demonstrate proficiency in basic skills on a standardized test and must have attained a grade-point average of at least 2.5 (on a four-point scale). The unit must have in place procedures for determining and monitoring students' progress and for providing them with appropriate advisory support" (Gollinick, 1986, p.313).

In the paper "GPA Tyranny," Milton, Pollio, and Eison (1988) examined three reviews of research literature on the relationship between GPA and post-undergraduate performance. The studies ranged in time from 1965 to 1984 covering 221 studies. These authors concluded:

The three reviewers were scholarly, cautious, and careful in reaching their almost identical conclusions: In essence, the research evidence suggests little or no relationship between college grades and any other measure of post-college activities (p.43).

What explained this inconsistency? The answer was that the GPA was not a good measure of aptitude because it was not a good measure of achievement. Milton, Pollio, and Eison (1988) have pointed out that the GPA has several statistical and theoretical problems:

- the GPA creates artificial accuracy or precision
- the GPA uses quantification under the guise of objectivity
- the GPA is a flawed statistic
- the GPA combines many inconsistent measurement instruments
- tests and grades affect student studying and learning

First, GPA carries the combined grades well beyond the precision of the original grade. Most college grades for any given course are composed of one or two significant digits (even at this stage, most serious students of evaluation would admit grades are only rough and inaccurate yardsticks). When the grades are combined mathematically most schools carry the calculations to three to six significant digits. This allows the schools to stratify the students "accurately" so they can be ranked. It is fine when we use a more precise measure, such as the percentage of correct answers on a test, to produce a less precise measure, in this case a letter grade. However, we reverse this logic when we move from a less precise measure, like a letter grade, to a more precise measure, like a

GPA carried to several significant digits. Milton, Pollio, and Eison (1988) explain it this way:

While it is logically and metrically proper to proceed from a more differentiated metric (percentage correct on a test) to a less differentiated one (ABCDF or variations thereof), it is much less proper to go from a less differentiated, inaccurate metric (ABCDF) to a more differentiated one - the GPA. The result is artificial accuracy or precision; absent initially, precision can not be divined by arithmetic. Statistical myopia causes this illusion of precision; it will be exacerbated by computers spewing decimals and insignificant minutiae (p.43).

The logic is clearly absent in a process which seems not only to ignore but to act in direct opposition to the fact that error variance increases when inaccurate measurements are combined.

Second, using a GPA to compare students defies another basic axiom of measurement: When using a measurement instrument to compare students the instruments must be equal. The grades which combine to form the GPA come from different courses taught by different instructors with different philosophies, different grading scales and different difficulty levels. Just as most institutions have no standardized system of assigning the course grades which comprise the GPA, the colleges themselves have agreed upon no standard method of computing GPA. In the Milton study, it was found that 57% of the colleges allowed the student to count only the last grade when a class was repeated. Most students repeat classes because of low grades. This inconsistency clearly affects the validity of the GPA.

Educators have never resolved the argument about whether grades should be norm based or criterion based. Perhaps norm-based and criterion-based grading can co-exist, but not if grades are to be used as an accurate method of comparing students. Consider also the student who transfers into a college at the beginning of his or her junior year, as many do, and starts with a clean GPA slate. Having completed most of their general education credits, these transfer students will frequently graduate with a significantly higher GPA than if they had spent their entire undergraduate career at the same institution. However, it is possible that students who transfer actually suffered in relationship to GPA. The most unlikely of all three possibilities is that GPA remains unaffected when students transfer. If colleges accepted grades from other schools, this would only make the problem worse. Although no easy solution exists for this problem, the fact remains that the effect of transfer upon GPA weakens the statistic as a measure of both achievement and aptitude.

A third and well-known basic fact of measurement also affects GPA: It is impossible to measure human cognitive variables without changing them. Students realizing the important effects of GPA will change their behavior to try to achieve a higher GPA. This effect can be beneficial; students could study harder. This effect can also work in reverse. Means and Means (1971) found that information provided to students about aptitude had a direct relationship to achievement for low achievers and an inverse relationship for high achievers. In other words, low achievers who were told they had high potential in the area of study achieved significantly above their real potential. In contrast, high achievers could be en-

couraged to achieve above their potential by telling them they had low potential. The effect can also be negative; students may cheat, or they may drop out of or avoid difficult courses. The Milton study found that a little more than half the students surveyed admitted to having cheated in college in order to receive a higher grade (about one third of college instructors admitted to the same thing) and that a little less than half the students surveyed had dropped a course in order to avoid getting a lower grade.

Fourth, the testing scheme many educators use to evaluate learning is only adequate to evaluate knowledge. Among the first things novice researchers learn about research design is the inadequacy of the one-shot case study. Lacking any way to determine how much the students knew before the educational experience, it becomes difficult to determine whether the knowledge was gained as a result of the experience being evaluated or of some other experience. The lack of any control prevents even one comparison and thus completely destroys internal validity. Isaac and Michael (1971) give the following warning about this very common testing method.

This approach usually involves "the error of misplaced precision"--a great deal of care given to the collection of data about which our conclusions can only be impressionistic and imprecise. It is simply not a basis from which we can reach defensible conclusions in research. The danger is that we will go this far, and no farther--that we will justify what we are doing in terms of impressionistic evidence alone (p. 36).

Finally, it seems the GPA survives in the face of clear and conclusive evidence that it neither accurately measures achievement nor predicts future success with appreciable validity. Americans seem to ascribe to

the belief that numbers are somehow objective simply because they lack a language component. Unfortunately, the exacting number system upon which this statistic is based does not guarantee the objectivity of the statistic. This is not surprising, since GPA defies many rules of statistics and measurement. Milton, Pollio, and Eison (1988) put it this way:

A frequently advanced argument for the use of GPAs for selection purposes is that descriptions of personality are "unreliable"--they have not been quantified. GPAs enable us to hide behind the mask of quantification; but most test, and the GPAs derived from them, are about as reliable as the meat scale at a dishonest butcher's shop (p.44).

Milton, Pollio and Eison are not the only researchers to question the wisdom of an over reliance on measures of academic achievement. Demott (1974), in reviewing literature on this concern stated:

The second is a development of a body of criticism of the SAT that is more sophisticated than any previous extent and is powerfully supportive of skepticism about the use to which the tests are put. Attacks on the SAT are, to be sure, not news: for more than a decade they've been in educational journals and general magazines (p.68).

He went on to suggest a test which would reflect a more flexible definition of intelligence--one which would consider the student's personal style of learning. Testing methods define a concept. What was included, what was emphasized, what was excluded all combine to form an operational definition of a concept. Unfortunately, in the fourteen years since Demott suggested we broaden our definition of intelligence, little has changed in this regard.

The problem became increasingly clear. NCATE, capitulating to the combined pressure of 1) the educational reform frenzy created by the various reports on education released during the early eighties and 2) the growing dissatisfaction of several large and influential schools, revised its accreditation system. Much of the revision included needed refinements. It also included the concept of a 2.5 GPA as an entry standard for education majors. The intention of this standard was clearly to screen out some of the less desirable "low achievers" who had gravitated to education. The ultimate result of this filtering was to have been the improvement of education via the elimination of this "riffraff" from the ranks. Convincing evidence existed which persuaded the researcher that using GPAs as the screening device was a poor way to achieve this goal. The traditional admissions formula of SATs and high school class rank (HSCR) does predict grades in college to a limited extent; most of these formulas account for 20% to 50% of the total variance. However, no research evidence could be found that these traditional measures of academic achievement were related to success in adult life. This was a surprising conclusion when the overdependence on GPA as a post-graduate selection criterion is considered. The unacceptable measurement error created when GPA is used as an entry criterion would cause the elimination of many capable students along with the less able. This left the researcher with a clear sense of purpose: create a system which could identify students who might be "screened" by the 2.5 GPA requirement. This would then allow for remediation strategies to help motivated and capable students meet the entry requirement.

## OTHER STUDIES

Predicting the success of beginning college students has been the topic of many research studies. These studies have come from a wide range of fields and have provided direction for this study. However, the author found few of these studies in the field of vocational education. One recent study in the field of technology education/industrial arts and two studies from the 1960s were found.

### Studies in the Field

The study which most closely reflects what the author was trying to accomplish was performed at Millersville University. Meys (1988) determined the relationship between SAT verbal, SAT quantitative and high school rank to final overall GPA of industrial arts students who graduated between 1983 and 1987. This study provided the most important direction of all the research reviewed. The historically high correlation between grade point average at graduation and grade point average taken at other points prior to graduation helped to encourage the careful consideration of the results of this research.

Meys studied students who graduated between July 1983 and July 1988. He found correlations with graduation grade point average as follows: with SAT verbal, .38337; with SAT math, .44132; with SAT total, .47786; with high school rank, .41355. The total correlation coefficient using a combination of SAT total and high school rank was reported as .54483.

Meys' study showed a moderate relationship between the traditional predictors of SAT scores and high school class rank to graduation grade point average. This correlation accounts for 29.68% of the variance in graduation grade point average.

Two older studies in the field of industrial arts/technology education were found. Turner (1965) found a correlation of .278 between high school grade point average and graduation grade point average for 104 industrial arts teacher education majors from Kansas State Teachers College. Baird (1969) found a .59 correlation between high school grade point average and graduation grade point average of junior college students in industrial arts and skilled trades. The usefulness of the Baird study for this research was limited, not only because it involved a junior college, but also because industrial arts students were combined with vocational trade students.

Three studies which involved predicting success in vocational education were found. One of the studies was a comparison of the performance of college agriculture students who did and did not study vocational agriculture in high school (Lester, 1964). In this study, no significant difference in performance in agriculture courses was found. However, the nonvocational agriculture group had a significantly higher overall college GPA. This overall difference in grades was due to a difference in math and English grades. The difference was further supported by the difference in SAT scores which also favored the nonvocational students. These findings reflect the "vocational tracking" in high school, which

results in keeping interested and capable students out of vocational programs. Technology education has less of a "vocational" reputation but suffered from the combined identification of not only "vocational education" but also "education" itself. A ten year study of trends in SAT scores, which concluded in 1986, yielded some interesting information about test takers who planned careers in education. Nationwide, students who declare an intention to major in education average 78 points less on their SAT scores than the average for all students taking the test. The students declaring education as a career path had an average class rank 4% below the average student taking the test (Grandy, 1987). This study was expected to show that industry and technology students were significantly below even the college of education average. Lester's study suggests two things. First, in order to have a reasonable chance to reach a 2.5 GPA, many students in education and specifically in the department of industry and technology will need help. Second, it suggests that SAT scores may be a good indicator of what type of help is needed.

The second study in the field of vocational education with implications pertinent to this study involved Predictive Models for Success in Occupational Education (Lynch, 1972). Three standardized tests designed to predict college success were administered to the same sample. The accuracy of each test was assessed, and the best test was used as a model to create an in-house predictive instrument. This instrument included emphasis on technical and vocational skills. This study suggests a possible outcome of the current research. A Millersville staff member could de-

velop a custom-made test to predict academic success based partially on what was learned from this investigation of various predictors.

The third study in the area of vocational education involved the prediction of academic success in five separate programs in health careers. High school class rank was the best predictor with a correlation of .52 (Anderson, 1971).

There were too few studies in the field of vocational education reviewed to reach any definitive conclusions. Nevertheless, predicting success in college in the field of vocational education in general, and technology education in particular, seemed to result in predictors with about the same correlations that other disciplines have developed from similar endeavors.

### **Studies Outside the Field**

Another study was of interest because of its similarity in methodology. In this study discriminant function analysis was used to predict which students would drop out of an agriculture program during or soon after their freshman year in the program (Stone, 1965). In this study only two predictors were used: the American College Test (ACT) and high school rank. Although the results were significant, a large proportion of the variance was left unexplained. These results were both encouraging and instructive. Certainly this researcher wishes to be able to explain a

significant proportion of the variance accounting for college success in this study.

McAndrew (1979) conducted A Comparison of Prediction Models Used for Predicting College Grade Point Average. She used regression analysis to conclude that a simple model using high school grades and SAT scores was as good as many of the fairly complex models which have been developed for the purpose of such predictions. Her model used the verbal and quantitative scores on the SAT combined with two parts of the high school GPA. The high school GPA was divided into a verbal variable and a quantitative variable. This study suggests hope for a simple model which could be very practical.

Eagle (1982) created a prediction equation for the purpose of early identification of potential dropouts. Multiple discriminant function analysis was used in this study to create the prediction equation. The results of the study were listed in Figure 3 on page 32.

The results of the Eagle study generally agree with the results of other studies in the literature. The use of discriminant function analysis to predict potential problems was an interesting parallel to this study. The finding that scholarships and grants were significant, but not loans, was instructive. Many loans are not need based, removing the relationship to parental income. The fact that age was not a significant predictor was noted, but the author still believed that age would be significant in this study. Socio-economic status was not found to be a significant

Conditions important in relationship to attrition:

1. high school rank
2. SAT scores
3. scholarships and grants (but not loans)
4. relationship between students' needs and psychological characteristics and the college environment

Conditions of marginal importance in relationship to attrition:

1. gender
2. parental education
3. study habits
4. motivational and educational goals
5. peer influence
6. individual personality characteristics

Conditions which were unimportant in relationship to attrition:

1. age
2. socio-economic status (high school GPA was used as a covariate)
3. size of high school
4. distance of college from home
5. public or private high school

Figure 3. Results of Eagle (1982) study

predictor of success, when controlled by using high school GPA as a covariate, but this is rather inconsistent with logic. Why should

socio-economic status not affect high school achievement in much the same way it affects college achievement? If this were the fact, as much research indicates, then controlling the effect of socio-economic status with high school GPA would remove the effect almost completely.

Most studies which predict academic success in college used a GPA from some time during the freshman year as the dependent variable. Since this study was concerned with a GPA at the end of the sophomore year, it became important to find research which supported the common-sense view that freshman GPA correlates well with subsequent achievement in college. Wilson (1983) conducted a review of literature with the goal of establishing the aforementioned relationship. He found, in fact, that freshman GPA was highly correlated with sophomore, junior, senior or graduation GPA. This review of research also contains an excellent summary of several studies with tables which reveal the correlations they found between common predictor variables and college GPA. A sample of these follows in Table 1 on page 34.

Several observations were appropriate in analyzing Wilson's research. First, the most common and strongest predictors of college success were high school class rank, SAT-V and SAT-M in that order of predictive power. Second, the Price and Kim study, which shows a positive correlation to age, encouraged the use of that variable in this study. Third, and perhaps most important, many colleges apparently use prediction equations with multiple correlations between .4 and .6. This indicates that col-

Table 1. Results of Various Studies Predicting College Achievement

Study	Predictors	Correlation to:	
Price and Kim (1976)	ACT HSCR age	GPA at second or third year 0.552 0.267 0.189	
Lunneborg (1977)	HSCR verbal math multiple R	fourth year GPA 0.51 0.42 0.34 0.57	
Hardesty (1980)	HSCR SAT-V SAT-M multiple R	Final GPA 0.57 0.43 0.40 0.625	
Wilson (1978,1980)	HSCR SAT-V SAT-M	first year GPA 0.55 0.44 0.44	final GPA 0.56 0.48 0.46
Chissom and Lanier (1975)	HSCR SAT-M SAT-V	first year GPA 0.46 0.39 0.37	

leges routinely make admission decisions based on variables which explain from 15% to 40% of the variance involved in college achievement.

Chissom and Lanier (1975) studied 669 freshmen at Georgia Southern College in 1973. When loaded into a multiple regression equation, the SATs explained an additional 12% of the total variance in addition to the 20% explained by HSCR.

Using data from the 1981 SATs, Lay and Wakstein (1984) collected a random sample which included 2% of all whites and 10% of all blacks who took the test for the purposes of comparing the two races. Their findings were several:

1. Blacks averaged 200 points lower than whites.
2. Since blacks are underrepresented (a smaller percentage of black high school students take the SATs) the actual difference in scores is probably underestimated.
3. Blacks have higher self-rated ability than whites at the same ability as measured by SAT scores.
4. SATs are not culturally biased. They predict college success for blacks and whites in different proportions; however, the prediction success rates were not significantly different.

Most of these findings were supported in the literature. Blacks, taken as a group, almost always scored lower than whites taken as a group. Whether this difference represents a cultural bias in the SAT (as other

studies have concluded) or an actual difference in aptitude was a controversy which was not necessary to resolve for the completion of this study.

McCornack (1983) explored the bias in admission equations. He created an admission equation based solely on white students and then applied it to Asian, Hispanic, black, and American Indian students. He theorized that if the equations were unbiased, they should predict an equal level of achievement with about the same amount of error when applied to the minority students. The equations produced a slight but significant over-prediction of the GPAs of Hispanic and black students. Only black students had a significantly different (lower) academic achievement.

Lyons (1985) conducted an experimental study to test intervention strategies designed to help high-risk freshmen. Students in the experimental group were matched roughly by ability with students in a control group. Despite the fact that students in the control group had a significant advantage in ability (an average of 75 points higher on SATs), the students in the treatment group received significantly higher GPAs than the students in the control group. Treatments included: (a) a test anxiety workshop; (b) assessment of current mode of studying/learning; (c) identification of behavior change necessary to improve study habits; (d) group activities to promote belonging, personal worth, self concept and self esteem. The results of this study provided a good beginning for the process of remediation of those students who were identified as potentially not meeting the 2.5 GPA criterion for admission.

Thornell and Jones (1986) created a regression equation to predict first semester college GPA using ACT scores and high school class rank as predictors. High school GPAs were found to have a 0.5957 correlation with first semester college GPA. ACT scores were found to have a 0.4345 correlation with first semester college GPA.

Some studies suggested the use of different prediction equations for different races or sexes. Durio (1980) produced one such study. Stafford and Council (1974) used the common multiple regression equation (SAT and HSCR as predictors of first semester college GPA). They found that the achievement of black students was consistently overestimated with the prediction formula. Dropping HSCR produced an equation which consistently underestimated the achievement of black students. These results were congruent with those of other studies which showed that black students had higher mean HSCR than white students with SAT mean scores as much as 200 points higher than black students. This seemed to indicate two things. First, the SAT had some cultural bias in operation. Secondly, it is possible that the black students came from schools which were still largely segregated with limited resources. GPAs taken from predominately black high schools may result in an overestimation of high school performance (Thomas, 1979). Likewise, although the schools may be legally desegregated, this has not prevented, in fact it has encouraged, white parents to move out of school districts with proportionally high black populations. The result is an increasingly minority and lower to lower-middle class white school population in many localities.

Concern over the cultural bias of SATs was well expressed by Thomas (1979):

The effectiveness of standardized test scores (relative to measures of high school performance) for predicting college grades of black students have been disputed. As a consequence, some colleges and universities have omitted the use of standardized test scores in their admission procedures in the belief that such scores are not predictively valid for black and other minority students. However, there is evidence that standardized test scores are not only valuable predictors of college grades for black students, but in some instances (particularly for black males), they may be more predictively valid than high school rank of average (p.6).

Thomas (1979) concluded that contrary to increasingly popular practice a combination of SATs and high school achievement should be used for the prediction of college achievement of minority students:

Colleges and universities that recruit black students with modest scholastic aptitude test scores should employ all relevant variables in deriving decisions concerning admission, placement, and deployment of remedial intervention strategies. High school grades or high school rank, when used alone, may not predict college grades for black students as well as test scores will; rank plus scores from tests of appropriate difficulty level are quite likely to predict better, via multiple regression techniques, than either does alone. This conclusion appears to be especially important in the case of black males (p.13).

Why the disparity between Thomas' conclusions and those of other researchers? This may be explained, at least in part, by the fact that Thomas drew his conclusions from research on a predominately black institution. His recommendations suggest that separate prediction equations for black students should include the SATs. The question of predicting the academic success of minority students remains a difficult topic.

Although SATs, HSCR, and other indicators of aptitude or achievement have been the subject of many studies, some studies have tested nonintellectual predictors of college achievement. Pedrini and Pedrini (1973) conducted an excellent review of such studies, which resulted in information on seven nonintellectual predictor variables listed in Table 2 on page 40.

Separate prediction equations for the sexes have been indicated by the research of Paraskevopoulos and Robinson in "Comparison of Regression Equations Predicting College Performance from High School Record and Admissions Test Scores for Males and Females" (1970). The researchers created different regression equations for the sexes, using the common variables of ACT scores and HSCR. They found that although there was no real difference in the slope of the two equations, the intercepts of the two equations were significantly different. In fact, they concluded that predictions based on only one regression equation for both sexes favored male applicants.

### PREDICTOR VARIABLES

Considerable research involving the prediction of college success was reviewed in an attempt to identify appropriate independent variables and initially rank their predictive power. The theoretical framework contains a review of the literature which helped rank the variables.

Several cognitive and noncognitive predictors have been identified in the literature. High school rank and standardized test scores have been the

Table 2. Results of Pedrini and Pedrini (1973) Study

predictor	results
socioeconomic level	positive correlation with achievement
race	correlation with achievement; standardized tests predict achievement of blacks at white colleges--not accurate at black colleges; separate prediction equations for races indicated
sex	women tend to achieve higher grades than men, which may be due to more rigid entrance requirements for women
marital status	not related to achievement
financial aid	not related to achievement
employment	less than 15 hours per week does not affect grades
special programs	programs designed for remediation of high-risk students have mixed results; no clear consensus can be determined

most prevalent cognitive measures. Many noncognitive variables have been suggested. Some of those commonly used in making admission decisions are not supported. Letters of recommendation and personal admissions interviews have little support in the literature (Stronck, 1979). However, other noncognitive predictors have been supported. Sex and race, although controversial, were frequently supported in the literature. Age, as a predictor of college success, received mixed reviews. Social capital is a relatively new concept which was tested in this research.

Many researchers agreed with Ayers and Rohr (1972) concerning the use of several predictors:

It is the belief of the authors that the 16PF (personality variables) should not be used alone in predicting achievement in the academic areas. A more valid and reliable prediction equation can be obtained by a combination of cognitive and personality variables. Cross-validation of results of several additional samples is needed... (p.493).

A vast amount was written about the use of SAT scores to predict college success. The SAT is intended to predict academic success in college. Any test which assesses the future rather than the past is likely to be controversial. This certainly holds true for the SAT. Hunter (1979) showed a correlation between SAT scores and freshman-year college grades. However, in a report to the Congressional Budget Office, Koretz (1986) warned against the prevalent mistake of equating SAT scores with educational achievement. His report pointed out the difference between taking a multiple choice test like the SAT and possessing the skills required to be successful in college: paying attention to long lectures, developing

the discipline necessary to do the required reading, and having the ability to write well-organized term papers.

Crouse (1986) claimed that requiring students to take the SAT was a waste of money. He used the National Longitudinal Survey (NLS) of high school students to calculate the accuracy of predictions based upon the SATs. He argues persuasively that a prediction of college success using high school grades and class rank gains little significance by the addition of the SAT scores to the prediction equation. Crouse wrote or collaborated on (Trusheim and Crouse, 1982; Jencks and Crouse, 1982) several articles about the use of SATs, using the NLS as a data base. The Trusheim article made the important point that the SATs do add a small but significant amount of predictive validity to high school records alone. However, comparing predictions made without the use of the SAT to those made with the SAT, using the SAT did not allow for a more accurate prediction of freshman GPA or degree attainment. Jencks made the point that calling the SAT an aptitude test is a misnomer. He explained that the ACT seems to predict college achievement just as well as the SAT. Indeed, Crouse claimed that the very fact that the predictive powers were so close added validity to the argument that the SAT is, in fact, an achievement test. Crouse concluded that the limited long-term predictive power of the SATs does not justify their expense.

Thornell and Jones (1986) cautioned against the increasing tendency toward using SAT scores as a barometer of national education. They point out the exclusive use of SAT scores as indicators of the health (or lack

thereof) of education in national magazines, large newspapers, and other public media. Even President Reagan, in calling for increased emphasis on education, used SAT scores as a bench mark.

Not all studies warned against the use of SATs as predictors of college success. Fincher (1974) gathered data from several different institutions in Georgia over a thirteen-year period. He concluded:

The analysis of data over the 13-year period gives firm evidence of the SAT's incremental effectiveness in supplementing the high school record as a predictor of college grades. The gain in predictive efficiency was appreciable for male and female students entering a diversity of institutions offering a variety of academic programs. The conclusion drawn is that the incremental effectiveness of the SAT is now firmly established... (p.304).

Mauger and Kolmodin (1975) also defended the validity of the SAT. They used exit GPA (taken from whenever the student leaves the university) and graduation GPA. The exit GPA proved a much better predictor than the graduation GPA. They pointed out that using graduation GPA involves a restriction of range--a valid point. If the dependent variable in these prediction studies was GPA during almost any point in college, the study most frequently ratified the validity of the SAT as a predictor. How closely college GPA was correlated with success beyond college is another question.

SAT scores are frequently used in studies conducted to predict college success. A few of the many studies which have found SAT scores to be valid predictors include: Krockover (1987), Stone (1965), Mcandrew (1979), Nisbet, Ruble and Schurr (1982), and Hunter (1979). Several studies

warned against the use of SAT scores as predictors of college success for black students: Wheatfall (1983), Horowitz (1972), Walter (1987), and Sampel and Seymour (1969). The studies by Horowitz and by Sampel and Seymour both warned that SAT scores are particularly invalid for black males. The Horowitz research indicated that high school class rank is a much better predictor than SATs for black males but SATs were valid predictors for black females (1972).

Millersville University requires SAT scores which were easily available to the researcher. They may have limited ability in predicting college achievement, but they do seem to explain a small but significant amount of variance when applied with HSCR.

High school grade point average and/or class rank were commonly agreed upon as valid predictors of college success. Very few studies attempted to predict college success without using one or both of these variables. A few of the studies which have found one of these variables to be paramount are: Spencer (1976), Doyle (1986), Bell (1984), Krockover (1987), and Crouse (1985). These and other studies clearly reflected a principal role for high school GPA or rank. Bistreich (1977) conducted a study to predict college success using seven variables. He divided high school achievement into several categories which included separate GPAs for math, English and science courses. Several of these variables remained significant in the prediction of success. The approach of dividing the significant explanatory power of high school achievement suggests just how powerful a predictor high school achievement is.

A few studies were found which included age as a predictor variable. Daus (1986) found that age was the best predictor of college success from the following list: race, age, credit load, financial aid, residence, sex and type of program. Price and Kim (1976) found that age ranked third behind ACT scores and high school class rank as a predictor of college success. They reported a correlation of .189 which explains only 3.6% of the variance. This small but significant predictor should be of more importance than indicated by the relatively small correlation in the above-mentioned study. Age should not be highly correlated to the other predictors; therefore, age should retain most of its predictive power when added to a prediction equation. Multiple regression must remove overlapping explanatory power in order to make an accurate assessment of the multiple correlation. This means that several highly correlated predictors may provide little more predictive power than any one individually, although they may all be good predictors taken individually.

Analysis of results reported in several studies indicated race to be a predictor of college success, especially if a minority student attended a predominantly white institution. Some of these studies were: Lay and Wakstein (1984), Stafford and Council (1974), Durio (1980), Daus (1986), McCornack (1983), and Pedrini and Pedrini (1973). However, the literature does indicate that a large error variance is involved in making such predictions, especially for black males.

Sex also appeared in the research as a predictor of college success. Females were found to be more predictable (less error was encountered in

predicting the achievement of females) by several studies. One study which emphasized this difference was Khan (1973). Several studies reported results which indicated that females perform better than males: Meys (1988), Pemberton (1970), Pedrini and Pedrini (1973), Paraskevopoulos and Robinson (1970), and Thomas (1979).

Coleman (1988), in reviewing his recent work Public and Private High Schools: the Impact of Communities, suggested that "social capital" explains significant amounts of variance in academic success. He included contributions of the family and the community to his concepts of human capital and social capital. Shortcomings in the family contribution can be made up by the community and vice versa. This idea helped him explain why poor students in private religious schools do so much better than poor students in public schools. The lack of human capital in the poor family can be offset by the strong social capital available within the private school community, Coleman maintained. Components of human capital mentioned included: parents' educational level, number of parents at home, and family income. Examples of factors which combine to form social capital include the strength of bonds across families and the intensity of adult interest in youth within the community.

Coleman's book, which is commonly referred to as "Public/Private," is a classic in educational research and should be considered required reading for all educators and parents. Further exploration of his theories is possible if the definitions of social and human capital are explored. Coleman (1987) explains the terms this way:

human capital in a family (as exemplified by the educational and cultural level of the parents), the social capital within the family (as exemplified by the presence of adults in the household and their degree of interest and involvement in their children's lives), and the social capital in the local community surrounding the household (as manifested by the degree of intergenerational closure in the community) (p.235).

Coleman defined these three terms:

Just as physical capital is created by working with materials to create tools that fabricate production, human capital is created by working with persons to produce in them skills and capabilities that make them more productive (Coleman, 1987, p.221).

Here Coleman emphasized the environmental nature of human capital. Social capital is essential if society is to prosper:

If physical capital is wholly tangible, being embodied in observable material form, and human capital is less tangible, being embodied in skills and knowledge acquired by an individual, social capital is less tangible yet, for it exists in the relations between people. Just as physical capital and human capital facilitate productive activity, social capital does as well (Coleman, 1987, p.221).

Closure in social networks is important to the concept of social capital. The strength and substance of relationships is central to social capital. The intensity of the relationships between adults in a community combines with the consensus these adults have on certain values to form closure in a society. Any parent, regardless of the amount of human capital he or she brings to a relationship, can greatly increase the likelihood that his or her child will become productive and successful simply by investing his or her time, interest, and concern in his or her child. However,

family social capital is frequently only part of the equation of success. As mention in a quote above community social capital is also important.

Community social capital involves the investment the community makes in an individual. What standards, morals and expectations the community transmits to its youth are in large measure dependent upon social capital. Parental values are oftentimes rendered meaningless if children are set in a social structure which contradicts or even distracts from these values. Closure in relationships is critical here also. Adults should have closure in their relationships with the other adults which form the community to support the school. Likewise, adults, other than a child's own parents, must have closure in relationships with youth in their community. Coleman (1987) explains it this way:

The social capital that we have described earlier as existing in religious communities surrounding a religious schools resides at least in part in the norms and sanctions that grow in such communities. These norms and sanctions in turn depend both on the social relations and the closure of networks created by these relations (p.222).

The reader may, by this point, share the researcher's dilemma. The concept of social capital, although it seems quite logical, leaves a problem for those who wish to make practical use of it. How does one measure social capital, given access only to the information most colleges have about their students?

Coleman's research can be considered capable of raising several highly emotionally charged questions. Whenever race and income are involved in

predicting academic success, there will be controversy. Coleman was no stranger to controversy, and his latest theories are no exception to this rule. Research abounds on both sides of this issue.

Wheatfall (1985) concluded that nothing he studied, including family income and residential setting, was related to achievement. His predictors included high school GPA and SAT scores; neither of these was found to be significant. However, nothing else the researcher reviewed, in an exhaustive search, concluded that neither SAT scores nor high school achievement was a predictor of college achievement. Nettles (1986) found significant differences between black and white students' college performance. Daus (1985), in a study previously mentioned, found that race and financial aid were good predictors of college success. This researcher has included variables related to social capital and race, without any attempt to prove anything about the superiority or inferiority of any group. Rather, it was the attempt of this study to identify those who need extra help in order to be successful.

### **THEORETICAL FRAMEWORK**

The attempt to develop a rank order of predictors based on available research was rather frustrating. Many studies can be found which employ the variables used as predictors in this study. However, few of these studies used more than three of the same variables used in this study.

Wilson (1973) reviewed studies of six admission formulas and found the predictors used were ranked as follows:

1. CEEB achievement average or HSCR
2. SAT-V
3. SAT-M

An extensive review of the literature on predicting college achievement led Pedrini and Pedrini (1973) to conclude:

While many factors are involved, it appears that for the majority of students applying for college entrance, the high school average (or class rank) is...the best single predictor of college grades; aptitude test scores...add appreciably to the accuracy of that prediction (p. 6).

Not surprisingly, their findings were ratified in much of the literature (see Other Studies section of this chapter).

Overall high school achievement seems to be the best predictor of college achievement. However, standardized test scores appear to be the best predictors for females. Consider, for example, the following results obtained from a sample of 1,812 freshmen from 1977-79, 75% of which were female. Correlations with college GPA are as follows: SAT-M, .569; SAT-V, .535; HSCR, .437 (Hengstler, 1981).

These approximate relative weights for HSCR and standardized test scores seem to hold true for most special groups. The notable exception occurs when race is used to form the groups. Neidich (1968) found the following

correlations to college GPA when he studies the achievement of 182 gifted students: HSCR .507, SAT-T

Chissom and Lanier (1975), Pedrini and Pedrini (1973), Wilson (1973), Neidich (1968), Lunneborg (1977), Hardesty (1980), and Wilson (1978, 1980) found high school rank was the predominant predictor of college academic success. SAT scores are also commonly reported as significant predictors, but aptitude was related to achievement. Using both high school rank and SAT scores as predictors reduces the correlation of the predictor loaded into the prediction equation second. This effect may put SAT scores as the third most correlated predictor.

The shared variance between SAT scores and HSCR which would probably push SAT scores to the number three position in terms of explanatory power, would allow social and human capital to move to the number two position. If financial aid were a better indicator of financial need, the number two position of this variable would be more secure. The questionable relationship between status of financial aid and financial condition make it difficult to be sure of the positions of the number two and three predictors.

It was difficult to differentiate between age, sex, and race as predictors, since some researchers argued that none of these were significant. The small minority and female population in the Department of Industry and Technology would probably reduce the predictive power of both sex and

race. This would place age as the number four predictor, race as number five, and sex as number six.

### SUMMARY

A wealth of research is available concerning predicting success in college. The literature also contains a sizable amount of information about the validity of the methods commonly used to make these predictions. The formula most commonly used by admission officers involved using multiple regression to create a prediction equation based upon high school class rank and a standardized test score. Normally the standardized test was either the Scholastic Aptitude Test or the Achievement Test. Although these predictors are statistically significant, they are not strongly correlated with college success. Much of what was written about the prediction of college success warned about the exclusive use of these predictors. Many people hold the misconception that since college admission officers commonly use SAT scores and HSCR to help decide which students to admit, these predictors must explain a significant amount of the variance involved in predicting college success. Rarely does the traditional college entrance formula explain even fifty percent of the variance involved in predicting college success. This suggests that caution must be exercised in the use of these predictions. However, the fact remains that we have nothing better.

Although not as strongly correlated, other predictors of college success were identified. Race and sex were identified by some as predictors of

college success, but they remain controversial. Age was identified as both significant and not significant. Social and human capital were considered by some to be good predictors of academic success.

Standardized test scores and high school achievement were identified most frequently as the best predictors of college success. High school achievement was usually slightly more strongly correlated with college achievement. Some studies concluded that adding other predictors increased the accuracy of the model, while others found that adding additional predictors changed the prediction very little. The interrelationship of most of these predictors made it difficult to improve the validity of the traditional prediction equation.

### CHAPTER III

#### RESEARCH DESIGN AND METHODOLOGY

This chapter contains the explanation of how the research was conducted. First, the students involved in creating the prediction were identified. Next, the group the prediction was intended for was identified. The research design was illustrated, and the methods employed to achieve this plan were reviewed.

#### STUDENTS USED IN CREATING THE PREDICTION EQUATION

The students used to create the prediction equation were assembled into three groups. Only students with valid records on the computer were used for the sample. One group was comprised of all freshmen entering the Department of Industry and Technology for the fall term of 1981 to the fall term of 1986 who eventually accumulated at least 30 semester hours by the end of their second year at Millersville. The other two groups were subsets of this first group. These second and third groups were created for the purpose of cross-validation. The second group was comprised of a random selection of 50% of the freshmen entering the Department of Industry and Technology for the fall term of 1981 to the fall term of 1986. A third group was comprised of all remaining freshmen entering the Department of Industry and Technology for the fall term of 1981 to the fall term of 1986. Rather than select members from only one of these freshman classes, the researcher used all available students in an effort

to keep the size of the group large enough to allow for valid inference. Including students from several different years introduced the possibility of a history effect. An analysis of variance was performed to assure that no significant history effect existed.

### **STUDENTS TARGETED FOR THE PREDICTION**

The equation will be applied to freshmen entering the Department of Industry and Technology at Millersville University during the fall of 1989. The prediction equation generated in this study allowed the researcher to predict which of these students would be at risk of not achieving a 2.5 GPA by the end of their sophomore year. This 2.5 GPA was critical, because it marks a cutoff for admission to the School of Education.

### **RESEARCH DESIGN**

A stepwise multiple linear regression was performed in order to create a prediction of which industry and technology students would be admissible to the School of Education according to the NCATE criterion. A GPA was predicted for each student. A computer program was created to discriminate between students who would have been accepted and those who would not have been accepted, according to the 2.5 GPA requirement. Students were sorted into two groups, "accepted" and "not accepted." The multiple regression technique allowed the creation of a prediction equation which would be used to identify students who would probably need remediation in order to meet the new NCATE requirement.

All students who entered the Department of Industry and Technology during the period from 1981 through 1986 were identified from admission records stored on one of Millersville University's computers. These records also included each student's verbal and quantitative SAT scores, high school rank, age, race, and status of financial aid. The data point for the GPAs was the end of the sophomore spring semester. Any students who had accumulated less than 30 semester hours of credit were dropped from the study completely. The selection of students was made by the computer according to a set of parameters set up in the program by the researcher. Sophomore grades were not available on the computer. They were obtained from the written records of the registrar and entered into a computer file.

## **MEASUREMENT**

This section discusses the six independent variables and the one dependent variables. The dependent variable was sophomore GPA. Students who accumulated less than 30 semester hours in two years were dropped completely from the study. This was done because they had not accumulated enough hours to make a reasonable assessment of their achievement. Likewise, students who had accumulated more than 100 hours two years after their entrance to the university were identified as transfer students entering with substantial transfer credits. Most of these students would have been assessed for admission to the School of Education at the time they applied for admission to the university. This made them inappropriate for the study, and they were also dropped from the study.

The independent variables representing quantitative and verbal aptitude were the quantitative and verbal scores on the SAT. The quantitative and verbal SAT scores taken from the computer undoubtedly represented the student's best SAT scores, since students who take the SAT during both the junior and senior year of high school are allowed to use the higher of the two scores. Millersville automatically accepts students with a combined SAT score of 800 or better if they rank in the top 50% of their class. However, the Department of Industry and Technology accepts an even larger percentage of students who apply. This liberal admissions policy should have removed almost all truncation of SAT scores. However, a data point which was at the end of the second year of college reintroduced some truncation. That is to say, some of the students with low SAT scores who were allowed to enter were probably not still in school at the second year data collection point.

The independent variable representing high school achievement was high school rank. The relationship between high school GPA and high school rank was direct and obvious, since GPA was used to determine school rank. Either of these closely related variables has proven to be an excellent predictors of college achievement. High school rank is a percentile rank which is calculated as follows:

$$\text{rank percentile} = \frac{\text{class size} - \text{class rank} \times 100}{\text{class size}}$$

A student with a rank of one then receives a percentile of ninety-nine. The percentile calculation helped to decrease but did not remove the problem that few of the freshmen came from the same high school. This meant that students were not compared to one another, which weakens the predictive value of the variable. However, the researcher projected that high school rank would be the best predictor of admission.

The independent variable representing maturity was age. The computer files simply reflect the student's date of birth. The year of birth was subtracted from the year of admission to yield age at admission.

The independent variable representing race was a dichotomous variable. One group was composed of whites and the other was composed of nonwhites. Again, these data came directly from the computer. The computer variable for race had five levels. One of the levels represented white; the other four represented other races. The four representing other races were combined to form one level identified as nonwhite.

The independent variable representing social and human capital involved four factors: (a) financial aid, (b) the number of activities in which students reported an interest, (c) admission status, and (d) the interaction between all three. The amount and types of need-based financial aid a student received were compared to his/her academic success. The

types of aid defined as need-based were listed in Table 3 on page 60. This variable was intended to reflect the human capital which students' parents brought to the relationship with their children. Some students did not receive financial aid because they did not seek it; therefore, the variable will not be completely representative of financial need. When students filled out their application to the university, they had the opportunity to express interest in several activities. A list of the activities which students had an opportunity to select is shown in Table 4 on page 61. A high interest in activities was postulated to be representative of a high rate of involvement of parents in students' lives, thus reflecting family social capital. The number and type of activities were compared to academic success. Many industrial arts/technology education students enter the university under special admissions programs (PACES or June/January) which are designed to admit students who would not normally be allowed to enter. This type of admission reflects a lack of human capital and was compared to academic success with the expectation that those admitted under one of these programs fared worse than those admitted normally in relation to GPA. The real power of the theories of social capital involves the interaction of several factors. The interaction of activities, special entrance, and financial aid status were compared to academic success to define social capital.

Table 3. Variables Representing Need-based Financial Aid

Variable name	Variable description
PELL	Pell grant (federal)
PHEAA	Commonwealth of Pennsylvania grant
SEOG	Supplemental Educational Opportunity Grant
PERK	Perkins loan
GSL	Guaranteed Student Loan
CWS	College Work-Study
*Note: Eligibility for all these programs is based in part upon financial need.	

Table 4. Variables Representing Activities

Label name	Variable description
AR	archery
BB	baseball
BK	basketball
XX	cross country
FH	field hockey
FB	football
GF	golf
LA	lacrosse
SO	soccer
SB	softball
SW	swimming
TE	tennis
TR	track
VB	volleyball
WR	wrestling
CBD	concert band
MBD	marching band
CHO	choir
ORC	orchestra
BDF	band front

<b>Label name</b>	<b>Variable description</b>
CH	cheerleading
DR	dramatics
PB	publications
GV	student government
RAD	radio station

## ANALYSIS

Stepwise multiple regression was used to create a prediction equation. This equation was used to identify students who would be likely to need remediation in order to meet the requirement for admission to the School of Education (2.5 GPA at the end of the sophomore year). The regression equation created was used to predict a GPA for each student. It then became a matter of simply examining each prediction to determine if it was equal to or above 2.5. Several steps were used to create and test the prediction equation. The equation was created according to the schedule listed in Figure 4 on page 64.

The multiple correlation coefficient of a regression equation can be used to estimate the accuracy of a prediction equation. However, this method usually overestimates the actual accuracy of the prediction. Cross-validation is used to test the accuracy of a prediction equation without having to wait for new data. The first step in this process is to divide the sample randomly into two groups of equal size. About 280 usable observations were expected. The 280 observations formed the major group, which was divided into two groups of about 140. A regression equation was developed for both groups and the groups served to cross-validate each other.

Each predictor was tested by the computer for significance. Beta weights were examined to determine the explanatory power of each variable. The researcher examined the data to determine cut-off scores for class rank

1. The data set was examined for missing or incorrect values and other inconsistencies which might cause problems.
2. Analysis of variance was used to check for a history effect. This was accomplished by determining if the year in which a student was admitted made a significant difference in sophomore GPA.
3. Analysis of variance was used to check for interaction listed in the social capital operational definition.
4. The SAS procedure "CORR" was used to check the correlation between each independent variable (predictors) and the dependent variable (sophomore GPA). The significance of each correlation was also reported.
5. Once the significant single correlations were identified, the process of accounting for multiple correlation began. The SAS procedure "RSQUARE" was used to select optimal subsets of independent (predictor) variables in the multiple regression equation. This procedure selects the best one, two, three, etc. independent variables and builds all possible models from them, thus creating an efficient method of building the best model from several possibilities.
6. Using the information from "RSQUARE," the best model was selected.
7. The SAS procedure "STEPWISE" with the option "MAXR" was used to identify the best order for the predictors in the equation. The procedure puts the predictors in an order which produces the highest possible correlation.
8. The SAS procedure "REG" was used to check the significance of the predictors and to build the prediction model. Several applications of "REG" used as nonessential predictors were dropped from the equation, and the model was rebuilt.
9. Assumptions were checked.
  - a. An analysis of residuals was performed.
    - 1) A check for outliers was executed to determine if the equation could be improved by removing outliers.
    - 2) The residuals were checked for normality.
  - b. Check for multicollinearity, determines if each predictor is a component of any other predictor
  - c. Check for nonlinearity, quadratic trends were analyzed
10. Cross-validation was performed to verify the accuracy of the prediction equation.

Figure 4. Data analysis

and SAT scores. The computer calculated a total R which demonstrated the correlation of the sum of the predictors to the dependent variable. Simply squaring the R determined the proportion of the variance in the criterion variable accounted for by the predictor variables.

The observations were randomly divided into two groups. Separate prediction equations were developed for both groups, and a cross-validation was performed for each one. The cross-validation involved applying the predictor equation to the other group and determining how many times it correctly discriminated between those who would and those who would not have been accepted according to the 2.5 GPA criterion. This provided a reasonable estimate of the percentage of times the equation would give a correct prediction when it was applied to actual first-time freshmen. Analyzing overshoots and undershoots provided information which helped improve the equation.

The Statistical Analysis System (SAS) was used to calculate the prediction equations. The statistical computer work was done on the mainframes at Millersville University.

### **SUMMARY**

Multiple linear regression was used to create the best possible equation to predict the sophomore GPA of students in the Department of Industry and Technology at Millersville University. The goal was to use this equation to predict the sophomore GPA of future students entering the

program. Double cross-validation was used to better define the amount of confidence the prediction equation deserved.

## CHAPTER IV

### RESULTS

This section contains the results of the investigation. First, the students are described; the average industry and technology student at Millersville University is described in terms of the variables investigated, and the trends relative to these variables are examined. Second, the research hypotheses are considered. Third, the statistical results are examined and a prediction equation is created.

#### DESCRIPTIVE STATISTICS

What does the average industry and technology student at Millersville University look like in terms of the variables collected? First, let us examine SAT scores and high school rank, including national and university-wide data for the purpose of comparison. These data are contained in Table 5 on page 68.

One must be very careful when interpreting statistics. A quick review of Table 5 on page 68 might lead one to conclude that Millersville's industry arts/technology education students (identified as IA/TE) fall somewhere between the national average of education students and the national average of all college students. This is not an altogether safe statement. The source of the national statistics for both education students and all students is the National Testing Service (NTS). The

Table 5. Mean SATs and HSCR

Predictor	Nationalx (overall)	Nationalx (education)	Millersville** (overall)	IA/TE mean	SD
SAT-V	427	394	469	407	72
SAT-M	471	426	513	461	77
SAT-T	900	822	982	868	124
HSCR	72	68	75	59	19
<p>* "Ten year trends in SAT Scores..."(Grandy, 1987); all students who took the SAT</p> <p>** "Millersville University Minifact Book" (1988) All students except PACE and June-January (programs designed to allow under prepared students to enter the university)</p> <p>Sample size: 273</p>					

table notes that these statistics include all students who took the SAT; many of these individuals may never have attended college. Many students who do attend college do not take the SAT. Frequently, older students are not required to produce SAT scores or high school class rank (see Table 8 on page 77). Perhaps it is safer to compare the statistics of industry and technology students to the statistics of Millersville University students in general.

The relationship between national overall and national education statistics in both SAT scores and HSCR reveals that the average student who intends to major in education is not as academically able as the average college student. This is a disappointing revelation to those who hope that a majority of education majors will be capable of achieving a 2.5 GPA by the end of their sophomore year. Even accounting for the fact that the figures in the column headed "Millersville" do not include special entrance programs, which are designed to allow academically disadvantaged students to enter the university, and that the figures under the column headed IA/TE do include these special entrance students, the size of the difference reveals that industry and technology students are not as well prepared academically as the average Millersville University student.

This lower academic ability was demonstrated by the fact that if all special entrance observations are removed from the industrial arts/technology education data base, the figures do not change that much; the average combined SAT score becomes 895 and the average class rank becomes the 60th percentile. This still represents a difference in SAT

scores of 87 and a difference of high school rank of 15 when comparing the adjusted scores of industrial arts/technology education students to all Millersville students. Just what does this information about cognitive capabilities mean? The industrial arts/technology education students' average SAT score of 895 is high than only 13.8% of the students at Millersville. A high school class rank of 60 is better than about 20% of the other students at Millersville. Less than 3% of Millersville's nonspecial entrance students fell below a 800 total SAT and below the 50th percentile in high school class rank. However, about 27% of the nonspecial entrance students in the Department of Industry and Technology fell into this category. Surprisingly, of the industrial arts/technology education students who fell below a total SAT of 800 and below 50th percentile in HSCR, 38% were successful in achieving a sophomore GPA of 2.5 or above.

Table 6 on page 72 shows the means of several other statistics relative to the industrial arts/technology education students. Information compiled about students' sophomore GPA and rate of successfully achieving a 2.5 GPA were recorded in Table 7 on page 73. These data indicated that fewer than one-half of the students achieved at least a 2.5 GPA (see Figure 5 on page 74).

The success rates of racial minorities (10%) was very low (see Figure 6 on page 75). The 2.5 GPA entrance requirement could eliminate most of the minority teacher candidates from the department. Females were

slightly more successful than males in achieving the 2.5 GPA (see Figure 7 on page 76).

Although students who were over 23 at the time of admission were eliminated from consideration for the purpose of the prediction equation, descriptive data were analyzed for these older students. Students who were over 23 years old at the time of admission were much less likely to have SAT scores or HSCRs. However, they were also about twice as likely to achieve the 2.5 GPA at the end of the sophomore year (see Table 8 on page 77 and Figure 8 on page 78).

The typical industrial arts/technology education student at Millersville University included in this study came to the university with below-average academic ability as measured by SAT scores and high school class rank. These students entered the university as a mix of traditional 18-year-old freshmen, slightly older transfer students, and considerably older nontraditional students (as old as 51 years). The overwhelming majority of these students were male and white. A relatively high percentage of these students came to the university under special entrance programs, and more than half of the students received need-based financial aid. Only 44% of these students achieved a 2.5 GPA by the end of their sophomore year.

Table 6. Age, Race, Sex, Special Entrance, and Financial Aid

Variable	Values	Notes
Age	average 18.59	range 17 to 23*
Race	263 whites 10 blacks	97% white 3.7% nonwhite
Sex	262 males 11 females	96% male 4% female
Special Entrance	54 total  36 June/January*** 20 PACES***	19.8% special admission 81.2% regular admission
Financial Aid ** (need-based)	155 total	56.8%
<p>n: 273            * all observations above 23 years of age were eliminated            ** data set from industrial arts data base years: 1984-85, 1985-86 and 1986-87            *** programs designed to admit academically disadvantaged students</p>		

Table 7. Actual Mean Sophomore GPA and Success Rate

<b>Variable</b>	<b>Result</b>	<b>SD</b>	<b>N</b>
Sophomore GPA	2.48 mean	0.51	273
Success in achieving 2.5 GPA	42.5%	273	

**Figure 5: Actual success of IA/TE students  
in obtaining a 2.5 GPA**

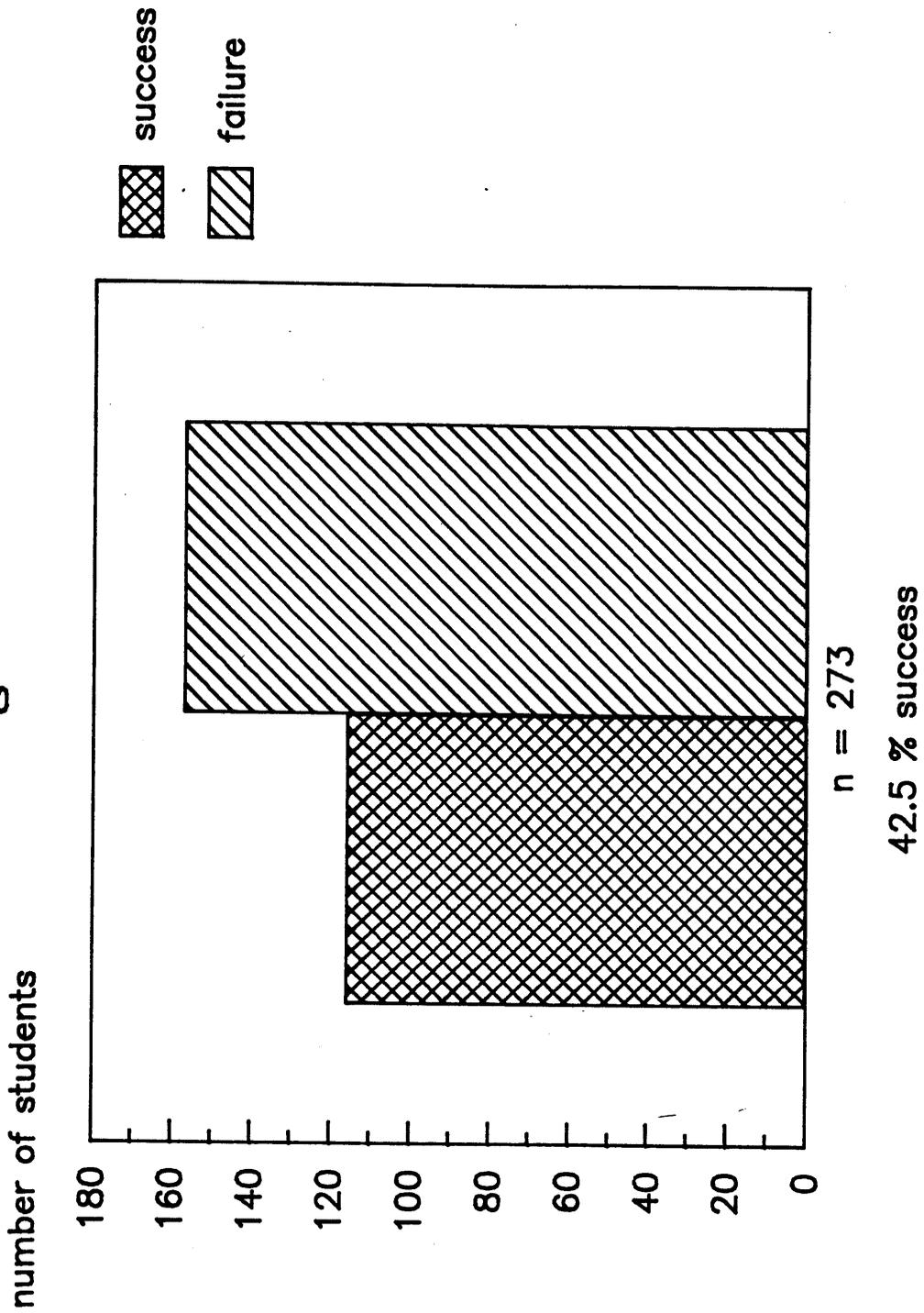


Figure 5. Actual success of IA/TE students in obtaining a 2.5 GPA

**Figure 6: Actual success of whites/nonwhites  
in obtaining a 2.5 GPA**

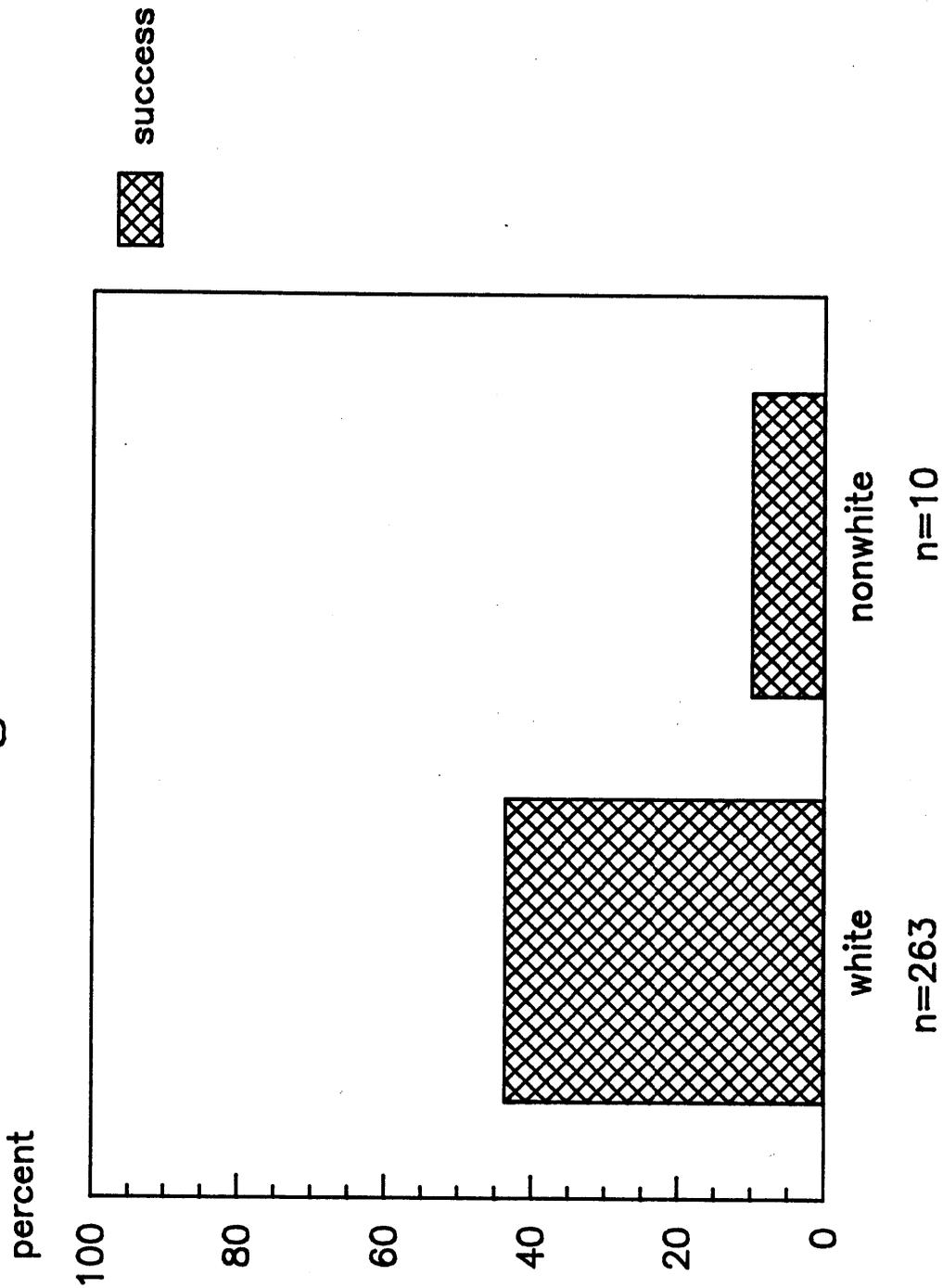


Figure 6. Actual success of whites/nonwhites in obtaining a 2.5 GPA

**Figure 7: Actual success of IA/TE students in obtaining a 2.5 GPA by gender**

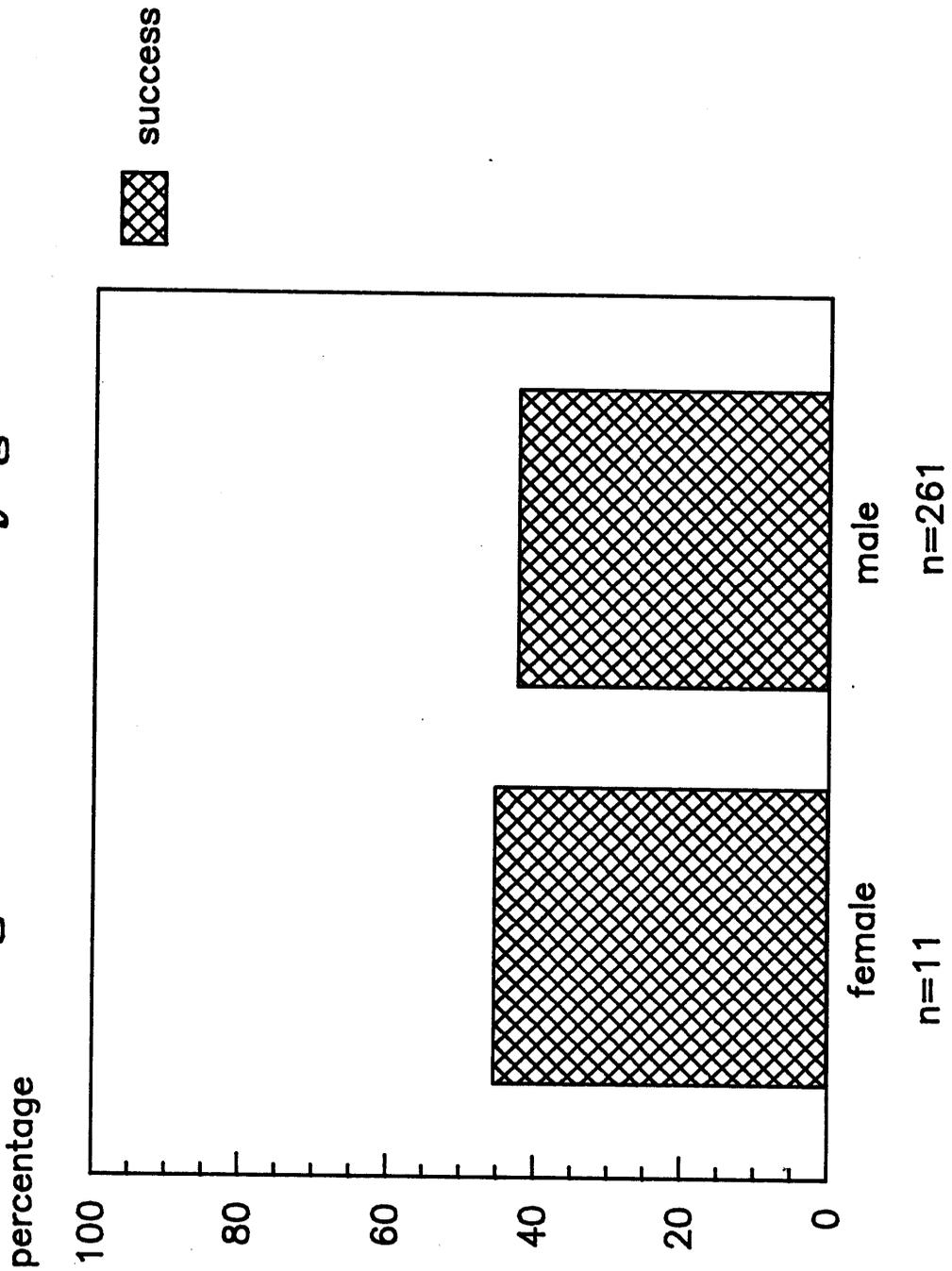


Figure 7. Actual success of IA/TE students in obtaining a 2.5 GPA by gender

Table 8. Age, Success with 2.5 GPA, SAT, and HSCR

admission age	success in achieving 2.5 GPA	have SAT and HSCR	part of department population	N
23 or less	42%	84%	94%	339
above 23	80%	10%	6%	20

**Figure 8: Actual success of IA/TE students in obtaining a 2.5 GPA by age**

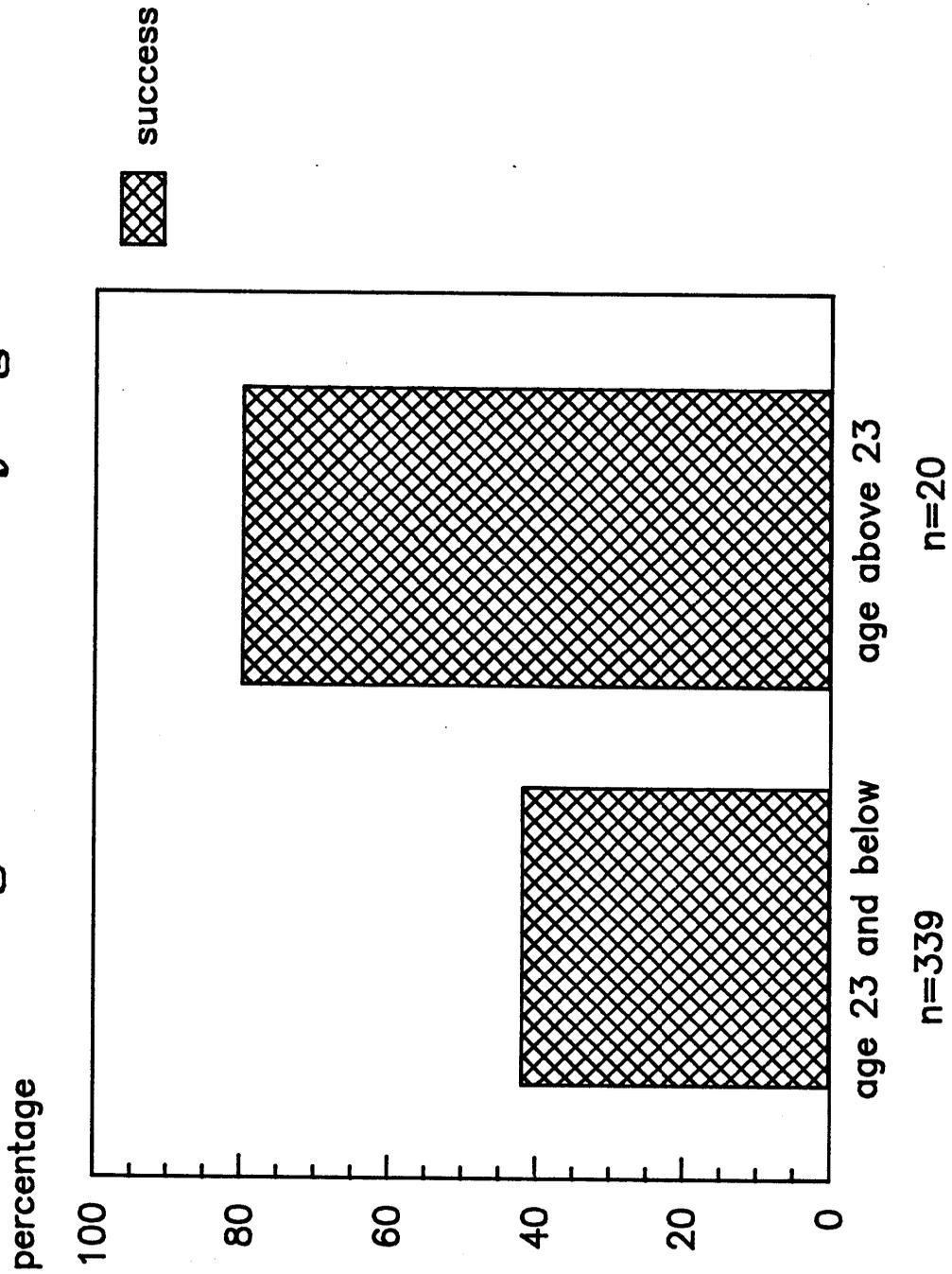


Figure 8. Actual success of IA/TE students in obtaining the 2.5 GPA by age

## TRENDS

Trends in cognitive variables are listed in Table 9 on page 80, in Figure 9 on page 81, in Figure 10 on page 82, and in Figure 11 on page 83. These figures indicate a fairly stable population in terms of cognitive ability. No clear trend of increase or decrease in relation to these cognitive variables could be identified. This indicates a relatively stable population in relationship to cognitive variables.

Trends in noncognitive variables are listed in Table 10 on page 85 and in Figure 12 on page 86. The trend in mean age was toward a slightly older student, although the trend did not represent a smooth curve or a straight line. The trend in sex might be a three-year cycle with peaks in female enrollment every three years (two cycles were not enough to identify such a trend). Generally, there was a slight increase of women in the department. Race may be a two-year cycle, but again two and one-half cycles were hardly enough to determine a pattern. Nonwhites were gradually but not consistently increasing in the department. Special-entrance students were also on a sporadic course toward increase. The concern over the increase in special-entrance students, which might represent an increase of lower ability students, was investigated by calculating the yearly change in the percentage of students with both a combined SAT score below 800 and a HSCR below the 50th percentile. The results of these calculations are listed in Table 11 on page 87 and are shown graphically in Figure 13 on page 88 and in Figure 14 on page 89

Table 9. Trends in SAT, HSCR, and GPA for IA/TE Students

Admission year	Combined SAT		HS class rank		Sophomore GPA		Success in achieving 2.5 GPA	N
	mean	SD	mean	SD	mean	SD		
1980-81	856	104	59.7	17	2.35	0.4	32%	25
1981-82	884	140	60.4	19	2.60	0.6	50%	42
1982-83	863	118	56.5	19	2.44	0.5	36%	44
1983-84	866	147	58.2	21	2.46	0.6	42%	36
1984-85	890	131	57	21	2.45	0.5	45%	53
1985-86	858	113	58	20	2.52	0.5	39%	33
1986-87	847	107	60.5	17	2.47	0.5	48%	40

**Figure 9: Mean combined SAT of IA/TE students by year**

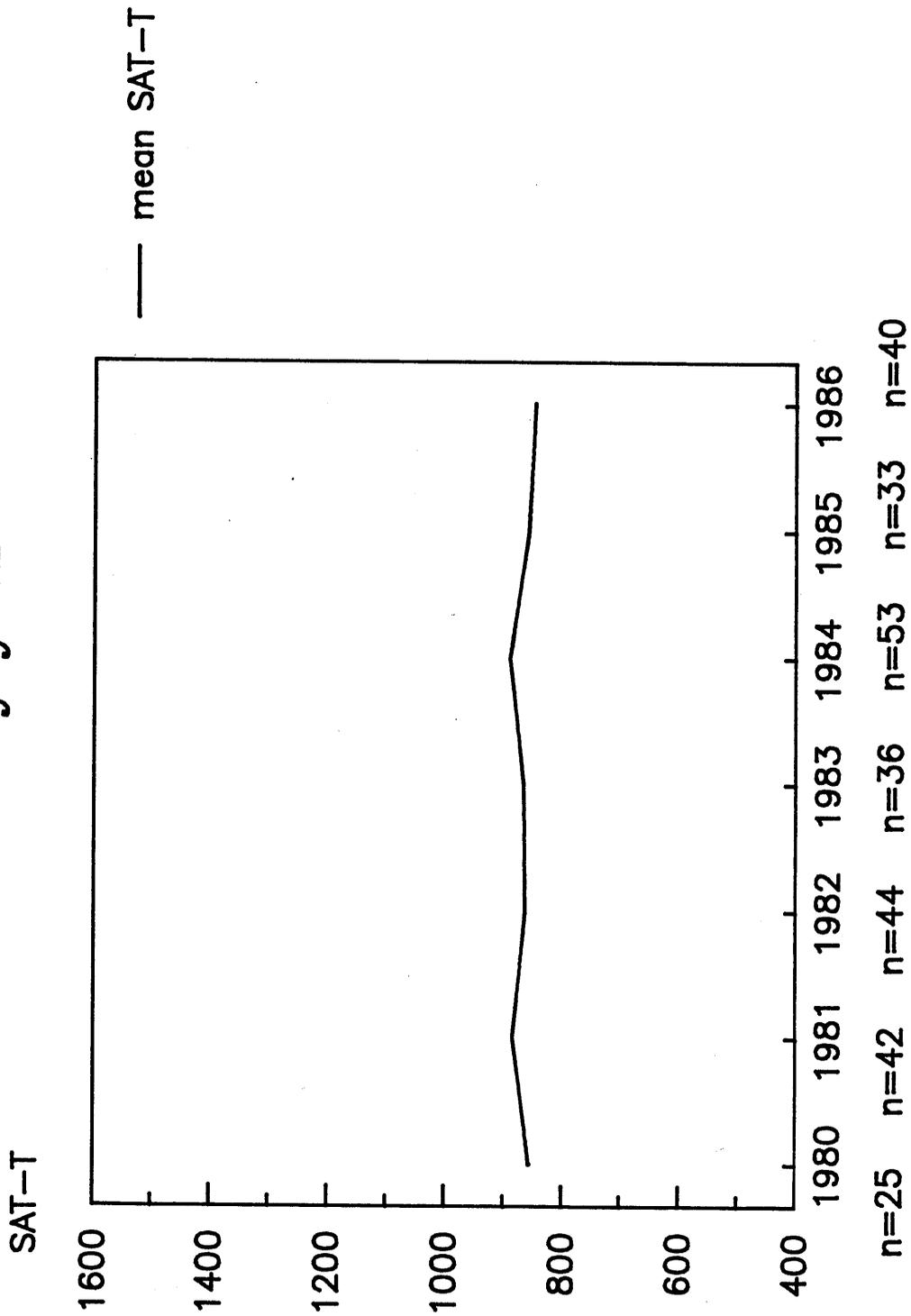


Figure 9. Mean combined SAT of IA/TE students by year

**Figure 10: Mean sophomore GPA of IA/TE students by year**

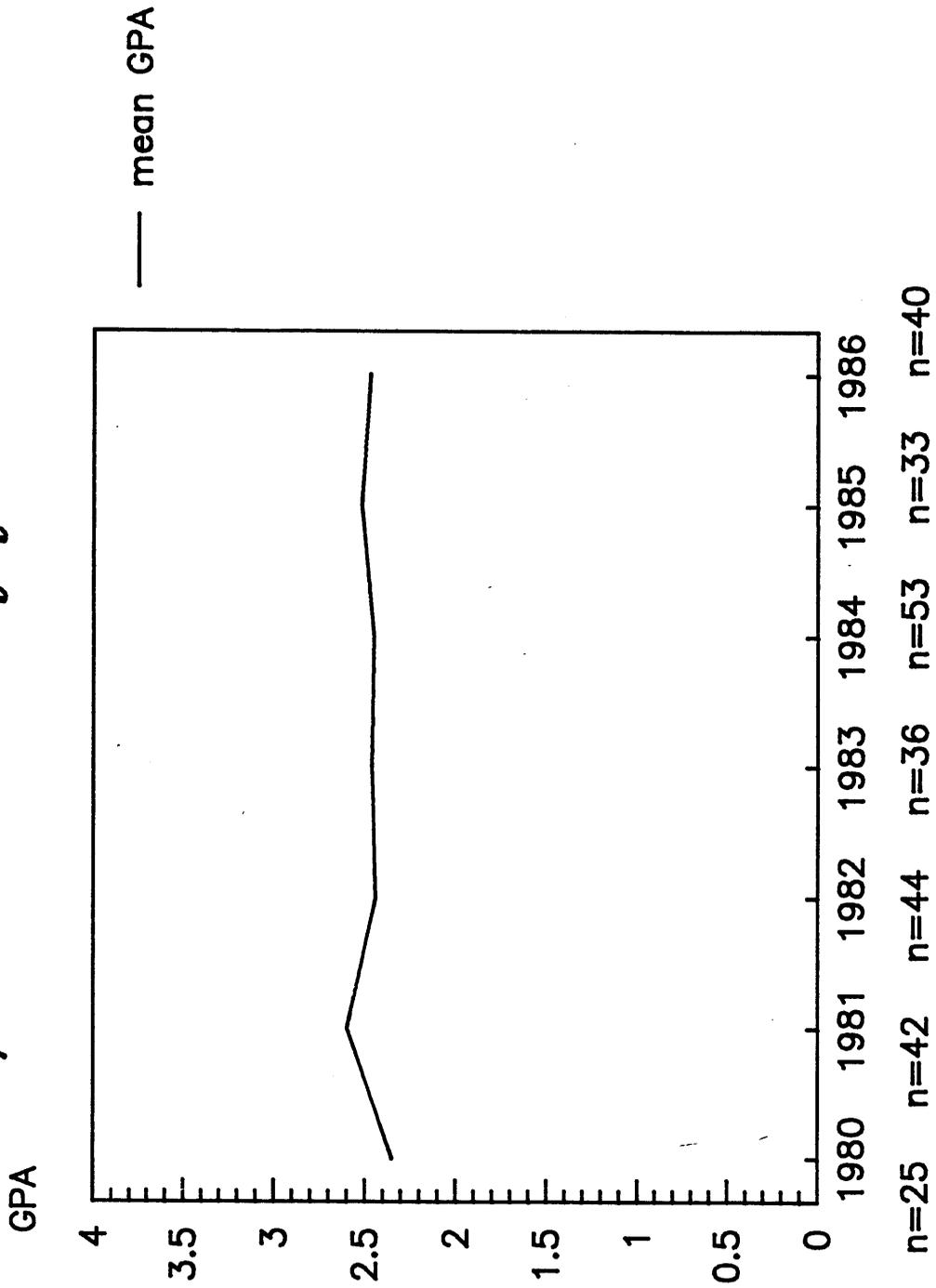


Figure 10. Mean sophomore GPA of IA/TE students by year

**Figure 11: Percentage of IA/TE students obtaining a 2.5 GPA by year**

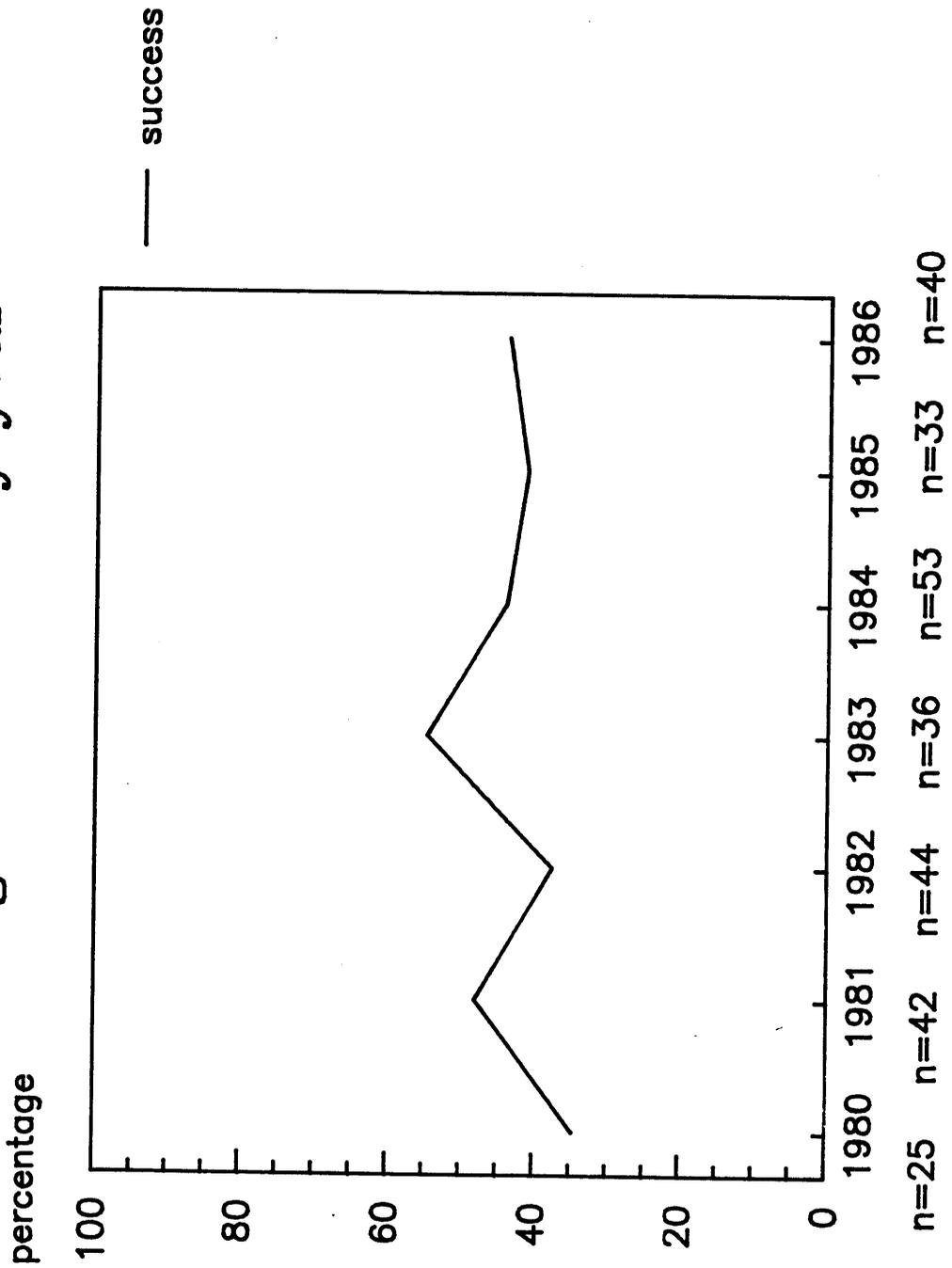


Figure 11. Percentage of IA/TE students obtaining 2.5 GPA by year

Table 10. Trends in Age, Sex, Race, Financial Aid and Admission Status of IA/TE Students

Admission year	Admission age*		Sex %male	Race %white	Financial aid % receiving need-based aid**	Special entrance % PACES or June-January***	N
	mean	SD					
1980-81	18.4	0.9	100%	96%	48%	8%	25
1981-82	18.6	1.0	98%	95%	48%	7%	42
1982-83	18.3	1.0	98%	100%	45%	9%	44
1983-84	18.7	1.0	94%	97%	75%	39%	36
1984-85	18.7	0.8	98%	100%	64%	11%	53
1985-86	18.6	1.1	97%	85%	67%	36%	33
1986-87	18.6	0.8	88%	98%	50%	33%	40

\* includes only students below 24 years of age  
 \*\* data incomplete for 1980-81 to 1982-83  
 \*\*\* designed to admit academically disadvantaged students

**Figure 12: Percentage of IA/TE students admitted under special programs by year**

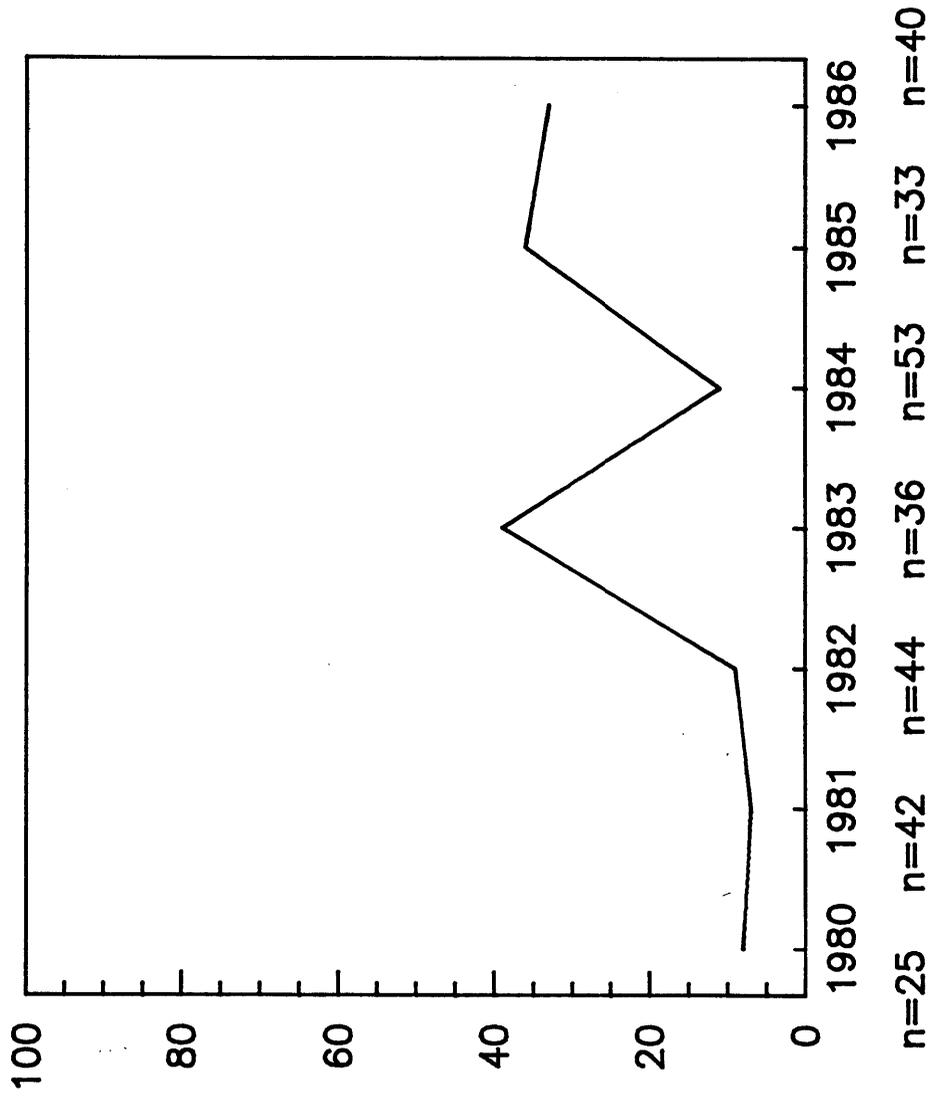


Figure 12. Percentage of IA/TE students admitted under special programs by year

Table 11. Trends of IA/TE Students With Low Academic Ability

Year of admission	Percent of students with SAT-T below 800 and HSCR below 50	Percent of students with SAT-T below 850 and HSCR below 60	N
1980-81	8.0%	24.0%	25
1981-82	9.5%	31.0%	42
1982-83	9.1%	31.8%	44
1983-84	13.9%	25.0%	36
1984-85	11.3%	22.6%	53
1985-86	9.1%	27.3%	33
1986-87	5.0%	27.5%	40

**Figure 13: Percentage of IA/TE students with below 800 SAT-T and 50 HSCR by year**

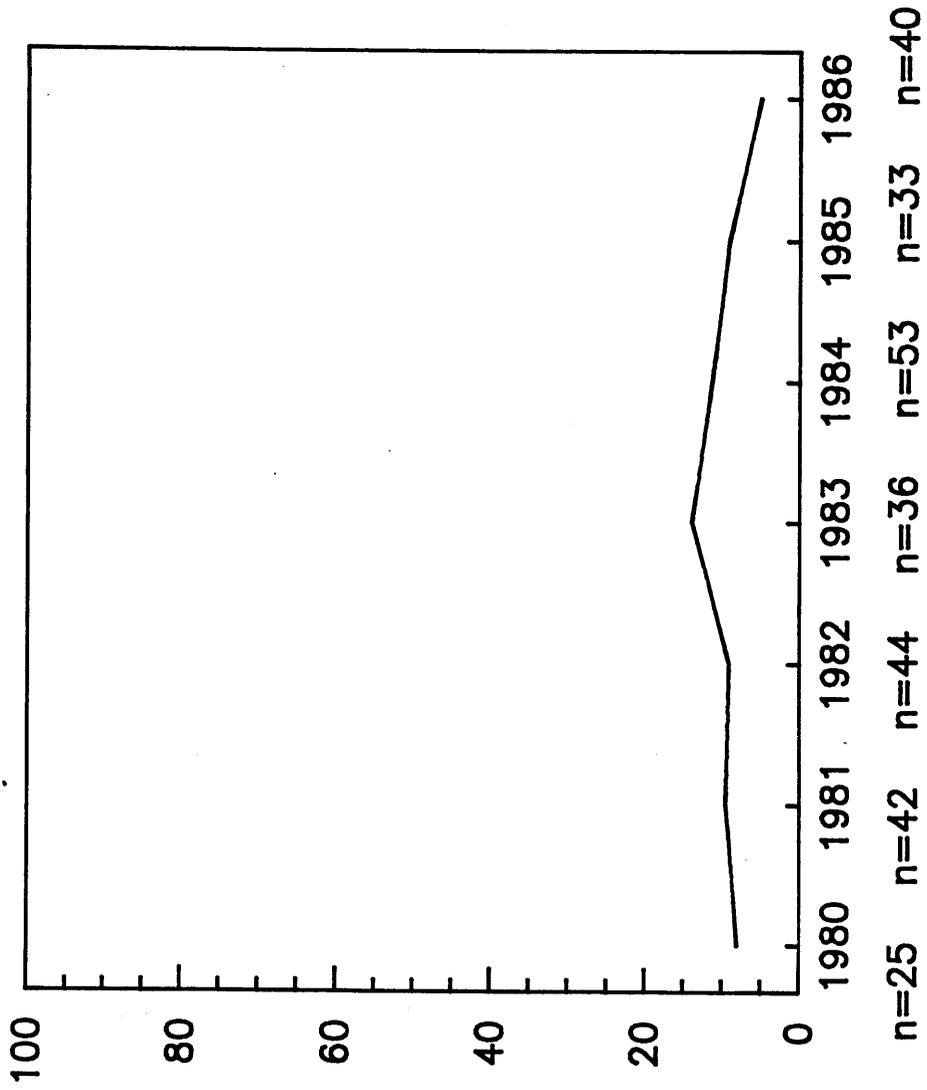


Figure 13. Percentage of IA/TE students with below 800 SAT-T and 50 HSCR by year

**Figure 14: Percentage of IA/TE students with below 850 SAT-T and 60 HSCR by year**

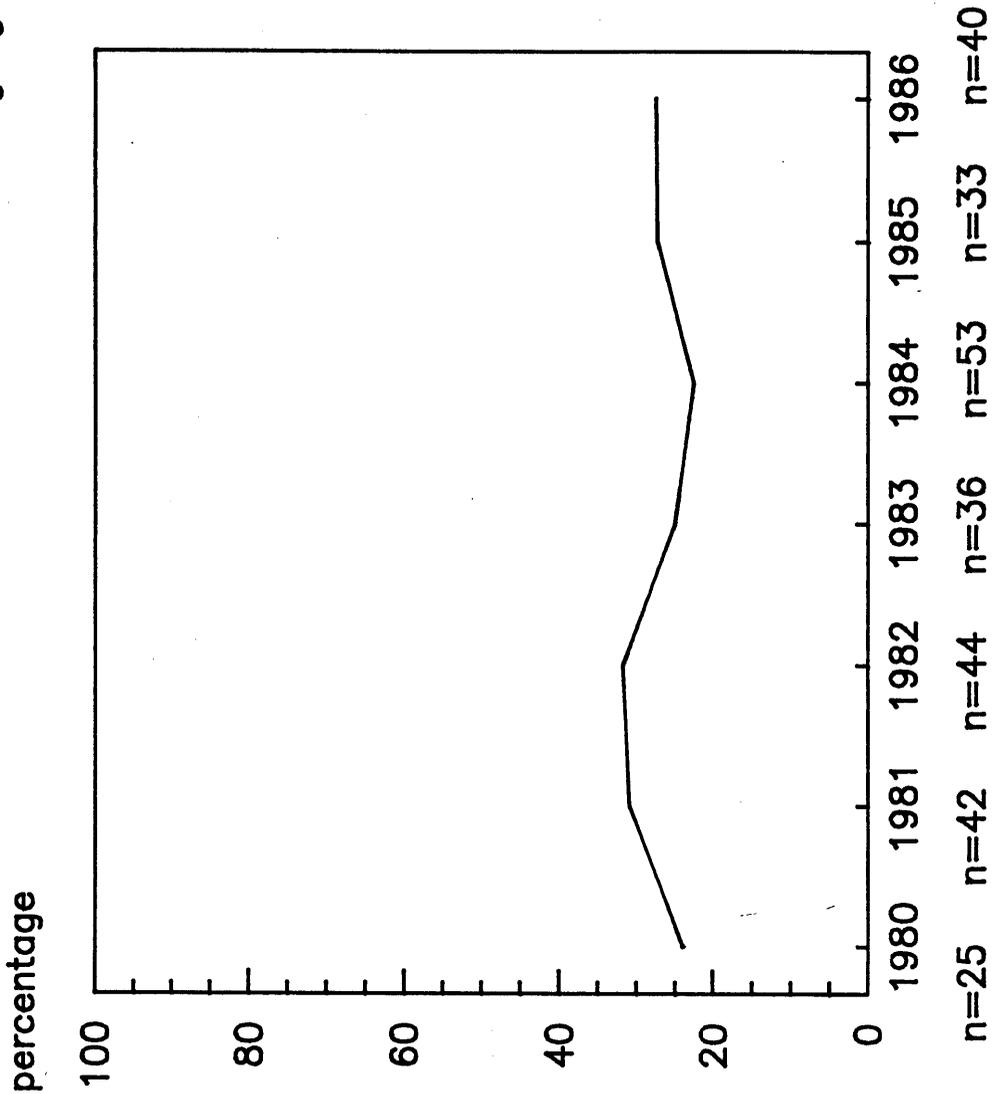


Figure 14. Percentage of IA/TE students with below 850 SAT-T and 60 HSCR by year

The trend, although neither linear nor consistent, was toward a higher percentage of underachieving students. Strangely, there was no logical connection between the percentage of academically disadvantaged students listed in Table 11 on page 87 and the mean total SAT score listed in Table 9. For a comparison of special admissions and under prepared academic students, see Figure 15 on page 90. There was no apparent relationship between the percentage of special entrance students listed in Table 10 on page 85 and the percentage of academically disadvantaged students listed in Figure 13 on page 88 and in Figure 14.

Most of the trends identified in this investigation were not significant if considered on a percentage basis. The exception to this was the fairly steady increase in academically under prepared students. A prediction of demographic trends on the basis of any of these variables would be a rough guess at best.

### **THE PREDICTION EQUATION**

The prediction equation was developed using a multistage process. The first step in this process was to examine the data base. This examination, based on a printout of each observation, revealed that many of the observations lacked data for SAT scores and high school class rank. Multiple correlation deletes the entire observation when even one piece of data is missing. Because SAT scores and HSCR are historically the best predictors available, this presented a real problem. Further examination

**Figure 15: Percentage of IA/TE students with < 800 SAT-T & 50 HSCR, special admission by year**

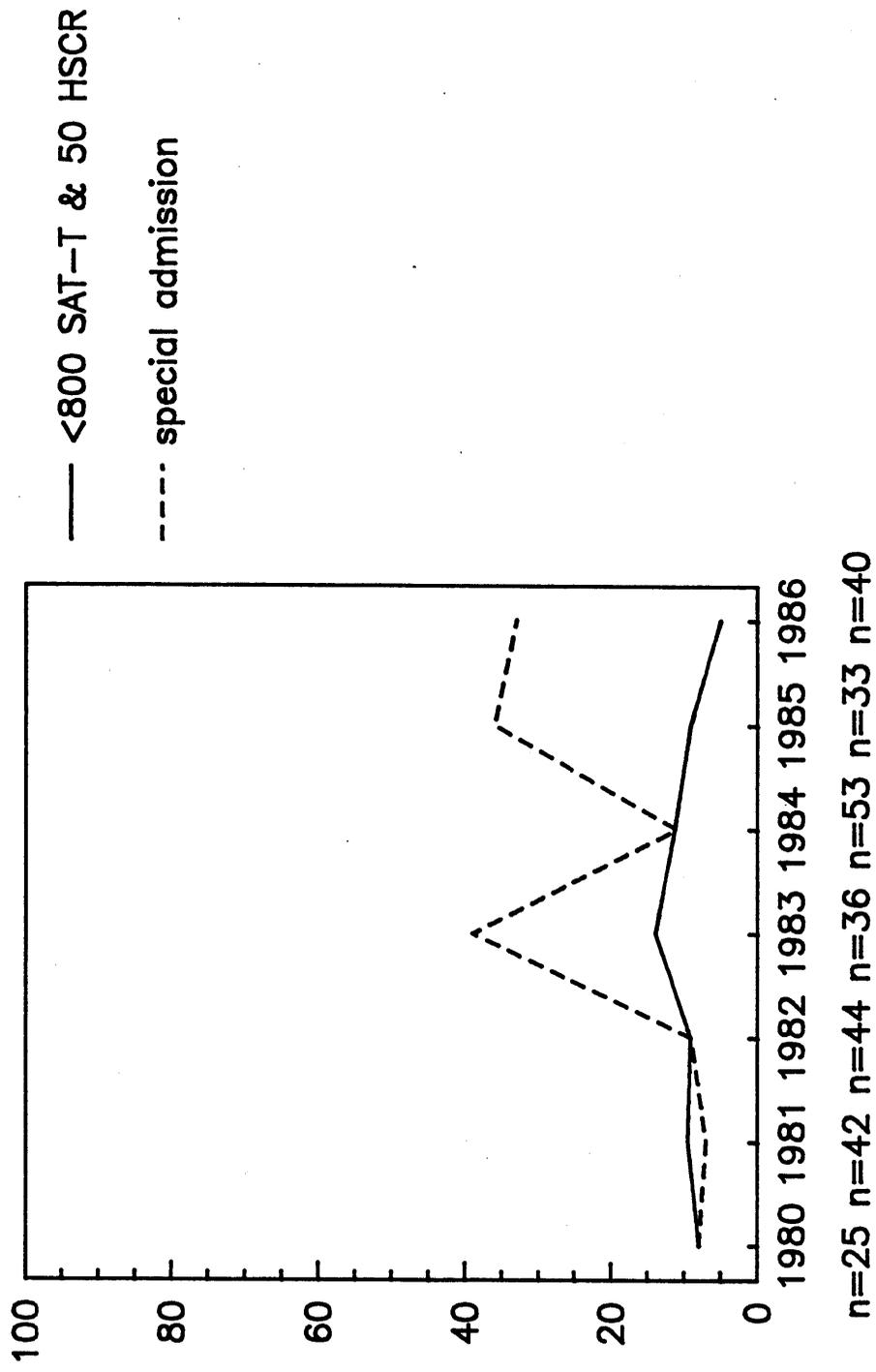


Figure 15. Percentage of IA/TE students with below 800 SAT-T and 50 HSCR, special admission by year

showed that the greatest percentage of the missing data came from older students. Table 8 on page 77 shows that only 10% of the students who were admitted when they were over 23 years old had reported SAT scores and HSCR. There was insufficient data to create a prediction for students over 23 years of age. Observations based upon students who were over 23 years of age when they entered the university were dropped from the analysis. Eliminating these observations changed the total number of observations from 359 to 273. This limitation was counteracted by the point that 80% of the students who were over 23 years old when they entered the program achieved a 2.5 GPA by the end of their sophomore year.

The second step in building the model was to check for a history effect. This was necessary because the data was collected over a seven-year period, introducing the possibility that time (history) may have made a significant contribution to college achievement. Analysis of variance for unbalanced cells was used to generate the information in Table 12 on page 92. The table clearly indicates that no significant history effect existed.

The third step in creating the prediction equation was to check for an interaction among the variables designed to represent social capital. A correlation matrix containing all the variables under study is contained in Table 13 on page 94. The variables representing social capital were financial aid, special admission, and the intention to participate in activities. Once again, an analysis of variance for unequal cells was used to analyze the data. Table 14 on page 95 reveals that no significant

Table 12. Analysis of Variance Used to Test for a History Effect

Year of admission	Sophomore GPA				
	mean	SD			
1980 - 1981	2.35	0.41			
1981 - 1982	2.60	0.58			
1982 - 1983	2.44	0.47			
1983 - 1984	2.46	0.59			
1984 - 1985	2.45	0.48			
1985 - 1986	2.52	0.54			
1986 - 1987	2.47	0.51			
Analysis of Variance					
Source	DF	Sum of squares	Mean square	F	Probability
year	6	1.23	0.21	0.77	0.59
error	266	70.76	0.27		
total	272	71.99			
model: sophomore GPA = admission year					

interactions exist. Special admissions was the only predictor which was significant. However, it would later be diluted because of its strong relationship to the much more powerful variable of SAT scores (admission is based on SAT scores, among other variables).

The fourth step in building the model was to determine the individual correlation of sophomore GPA to each of the predictors. Reading only the first row in Table 13 on page 94 yields these correlations. Variables representing special entrance, high school class rank, SAT math, SAT verbal, race, and age showed a significant relationship to sophomore GPA. These variables were kept in the analysis for further consideration. Certain other variables were also left to be examined in the following step: (a) the number of activities in which a student expressed interest, (b) the total dollar amount of financial aid a student received, and (c) whether a the student received any financial aid. It was suspected that although these variables were not significantly correlated with GPA when considered individually, they might be significant in a multiple correlation equation.

The fifth step in the development of a prediction equation was to check all possible combinations of the predictors in order to obtain the highest correlation. SAS procedure RSQUARE was used to accomplish this. RSQUARE is a procedure specifically designed to help with model building. Table 15 on page 97 shows the percentage of total variance accounted for when only one variable was loaded into the model. Considering the correlations of each variable to GPA, the only variables worthy of further

Table 13. Correlation Matrix for All Variables in the Study

<b>Pearsons Correlation Coefficients / Probability</b>										
	<b>GPA</b>	<b>SE</b>	<b>ACT</b>	<b>FINA</b>	<b>Rank</b>	<b>SATM</b>	<b>SATV</b>	<b>Race</b>	<b>Age</b>	<b>Sex</b>
<b>GPA</b>	1.0 0.00	-0.2 0.00	0.0 0.81	-0.1 0.17	0.5 0.00	0.4 0.00	0.4 0.00	-0.2 0.00	0.1 0.02	0.0 0.57
<b>special entrance(SE)</b>		1.0 0.00	0.1 0.02	0.2 0.00	-0.2 0.00	-0.4 0.00	-0.3 0.00	0.2 0.00	0.0 0.75	0.1 0.16
<b>activities (ACT)</b>			1.0 0.00	0.1 0.08	-0.0 0.78	-0.1 0.13	-0.1 0.25	0.1 0.03	0.0 0.84	0.2 0.00
<b>financial aid (FINA)</b>				1.0 0.00	-0.1 0.30	-0.1 0.04	-0.2 0.01	0.2 0.00	0.1 0.09	0.0 0.82
<b>high school class rank (rank)</b>					1.0 0.00	0.3 0.00	0.3 0.00	-0.1 0.33	-0.1 0.03	0.1 0.21
<b>SAT Math (SATM)</b>						1.0 0.00	0.4 0.00	-0.2 0.00	-0.1 0.38	-0.0 0.94
<b>SAT Verbal (SATV)</b>							1.0 0.00	-0.2 0.00	0.0 0.77	0.1 0.27
<b>race</b>								1.0 0.00	0.0 0.71	-0.0 0.51
<b>admission age (age)</b>									1.0 0.00	-0.1 0.14
<b>sex</b>										1.0 0.00
N = 273										

Table 14. Test for an Interaction Among the Variables Representing Social Capital

Source	DF	Sum of squares	F	Probability
model**	7	6.1	2.5	0.014*
financial aid (FA)	1	0.2	0.5	0.48
activities (ACT)	1	1.1	3.2	0.07
special admission (SA)	1	3.8	11.2	0.001*
FA * ACT	1	0.6	1.8	0.18
FA * SA	1	0.4	1.1	0.30
ACT * SA	1	0	0	0.95
FA * ACT * SA	1	0.1	0.2	0.68
error	351	119		
total	358	126		
** model: $GPA = FA + ACT + SA$				

investigation were: HSCR, SAT-M, SAT-V, special admission, race, and admission age. RSQUARE also produces data on all possible multivariate models. The procedure calculates the correlations for every possible combination of variables. This accounts for the mutual interaction of the variables.

Examination of the multivariate data created by RSQUARE yields a model including HSCR, SAT-M, SAT-V, admission age, and race. Special admission was eliminated by its strong relationship to SAT scores. The SAS procedure for general linear models (GLM) was used next to check the significance level of the remaining predictors. GLM uses a least-squares procedure to fit a linear equation to the variables in question. The results of this procedure are in Table 16 on page 98.

Despite a large difference in the means (nonwhites had a mean GPA of 1.9 while whites had a mean GPA of 2.5) the analysis failed to assign significance to race as a predictor (Table 16 on page 98). The small size of the cell (10 nonwhites in the sample) accounts for the lack of confidence in race as a predictor. Race was removed from the prediction equation.

The order in which variables are entered into a regression equation is important. Therefore, a special procedure in SAS called STEPWISE was used at this point to determine the order which would produce the highest final multiple correlation coefficient. The procedure showed that the vari-

Table 15. Model building with R-SQUARE

<b>independent variable</b>	<b>r-square*</b>
HSCR	0.198
SAT-M	0.196
SAT-V	0.138
special admission	0.057
race	0.038
admission age	0.030
financial aid	0.004
sex	0.001
activities	0.000
* squared correlation Model: sophomore GPA = independent variable	

Table 16. Regression of HSCR, SATs, Race and Admission Age on IA/TE Students

Source	DF	Sum of squares	F	Probability
H. S. rank	1	15.1	89.7	0.00*
SAT-M	1	6.9	41.5	0.00*
admission age	1	3.0	18.0	0.00*
SAT-V	1	1.4	8.1	0.00*
race	1	0.6	3.4	0.06

ables should be loaded into the equation in the following order: (a) high school rank (PCNT), (b) SAT-M, (c) admission age, and (d) SAT-V.

The final step in model building was to use the SAS procedure for regression (REG) to build the final model. The results of this procedure are listed in Table 17 on page 100. The final prediction equation is listed in Figure 16 on page 101.

When the prediction equation was applied to the entire data set, it correctly predicted acceptance or rejection (based upon the 2.5 GPA) with 71.4% accuracy. This was slightly below the prediction of error reduction one might make by simply considering the multiple correlation coefficient of the prediction equation. The prediction based upon the multiple correlation coefficient of 0.37 would be the 50% which could be placed in the correct group by chance plus the 37% accounted for by the equation. In other words, the multiple correlation coefficient alone would lead to a prediction of 87% accuracy. The confounding factor was that the mean GPA for the sample was 2.477, which was very close to the cutoff score of 2.5. This allowed the error variance in the prediction equation to put more of the predictions on the wrong side of the 2.5 cutoff than would have been the case if the actual mean GPA had been further away from a 2.5.

A check of outliers revealed six observations which were not grouped with the main cluster of observations. These outliers were on the extremes (very high or very low predictions). Removing these observations resulted

Table 17. Final Regression Results

Variable	Probability	Squared partial correlation	Parameter estimate
intercept	0.0099		-1.3904
H. S. rank	0.0001*	0.2491	0.0096
SAT-M	0.0001*	0.1329	0.0018
age	0.0001*	0.0624	0.1080
SAT-V	0.0051*	0.0289	0.0011
multiple squared correlation coefficient 0.3676			
standard deviation of prediction equation = 0.4121			

$$\text{GPA} = -1.3904 + \text{HSCR}(.0096) + \text{SAT-M}(.0018) + \\ \text{admission age}(.1080) + \text{SAT-V}(.0011)$$

Figure 16. Final prediction equation

in a slightly higher multiple correlation coefficient of 0.3842, while increasing the prediction of acceptance only very slightly to 71.6%. These results did not justify changing the prediction equation.

The normality of the residuals was also checked. The residuals were plotted and examined, and a box plot was employed. The residuals were found to be within acceptable limits of normality.

No collinearity was found in the analysis. The collinearity diagnostics involved examining condition indices of the variables. This indicates that no variable is a nearly linear combination of any other variable.

A quadratic component was added to a series of model statements to check for nonlinear trends. Each model statement contained only the predictor and its appropriate quadratic. Simply comparing the resulting multiple correlation coefficient to the correlation between the predictor by itself and GPA revealed whether a nonlinear trend existed. A nonlinear trend would result in a higher correlation to the equation containing the quadratic. All the variables in the final regression equation were tested. No evidence of any nonlinear trends was discovered.

The final step in creating the prediction equation was cross-validation. The data set was randomly divided into two equal parts, and a prediction equation was developed for each subgroup. Each prediction equation was then applied to the other group. Table 18 on page 105 shows the results of this process. The cross-validation equations (see Figure 17 on page

104) were slightly better than the original equation at predicting admission; the average correct prediction was 72.2% (see -- Table id '' unknown -- refid=cross). The cross-validation strongly supports the argument that the predictors identified in the equation are not simply a result of random error.

## **REVIEW OF HYPOTHESES**

The preceding description of the model-building process contains information concerning each hypothesis. However, for the sake of clarity, each hypothesis is restated here and the results of the analysis are used to reach a conclusion concerning each hypothesis.

### **Overall Hypothesis**

Millersville University's industry and technology students' GPAs can be predicted using a multiple regression equation developed from the following predictors:

1. SAT scores
2. high school rank
3. age
4. financial aid
5. race
6. sex

**Cross Validation Group 1**

squared correlation: 0.3820      probability: 0.0001

$$\text{GPA} = -1.704 + \text{HSCR}(.0099) + \text{SAT-T}(.0013) + \\ \text{admission age}(.1357)$$

N = 130

**Cross Validation Group 2**

squared correlation: 0.3481      probability: 0.0001

$$\text{GPA} = -1.122 + \text{HSCR}(.0095) + \text{SAT-T}(.0017) + \\ \text{admission age}(.0838)$$

N = 143

Figure 17. Cross validation prediction equations

Table 18. Prediction Accuracy of the Cross-Validation

Data subset	Prediction accuracy using the opposite equation
cross 1	70.1%
cross 2	74.3%
average	72.2%

A statistically significant prediction equation was created. However, not all of the predictors listed above remained in the equation. The predictive validity of each individual predictor is discussed in the following section.

### **Subhypotheses**

The exact relationships between variables are listed below:

1. Industry and technology students who had a GPA of 2.5 or above at the end of their sophomore year scored significantly higher on the SAT than those who had below a 2.5 GPA. **This hypothesis held true.**
2. Industry and technology students who had a GPA of 2.5 or above at the end of their sophomore year ranked significantly higher in their high school graduating class than those who had below a 2.5 GPA. **This hypothesis held true.**
3. Industry and technology students who had a GPA of 2.5 or above at the end of their sophomore year had a significantly higher age than those who had below a 2.5 GPA. **This hypothesis held true.**
4. Industry and technology students who had a GPA of 2.5 or above at the end of their sophomore year had parents with a significantly higher income than those who had below a 2.5 GPA. This higher income was represented by a lack of need-based financial aid. Students who were successful in achieving the 2.5 GPA also indicated an interest in more activities than the unsuccessful students. Significantly fewer of the students who went on to meet the 2.5 GPA criterion had been ad-

mitted under a special admissions program than those who had entered under normal admissions. The interaction of these three variables also helped predict which students would make the 2.5 GPA. **This hypothesis did not hold true.** The possibility of type II error exists. The failure to prove statistical significance could be the result of inadequate operational definitions or the lack of access to appropriate financial data.

5. A significantly higher percentage of white industry and technology students had a GPA of 2.5 or above at the end of their sophomore year than those industry and technology students of any other race. **This hypothesis did not hold true.** The probability of type II error is supported in this case by the small number of minorities in the study.
6. A significantly higher percentage of female industry and technology students had a GPA of 2.5 or above at the end of their sophomore year than male industry and technology students. **This hypothesis did not hold true.** Once again, the possibility of type II error exists because of the small number of females in the study.

#### SUMMARY

The average industrial arts/technology education student at Millersville University is not as academically able as the average Millersville University student. This fact is exemplified by the increasing percentage of industrial arts/technology education students who enter the university under programs designed to admit under prepared students. Except for this

slight increase in special entrance students, and a slight increase in enrollment, the department appears to be fairly stable.

Students who were over 23 years old when they entered the program were eliminated from the study, because most of them did not have SAT scores or high school ranks. Predictors with a significance level of 0.05 had the following squared correlations with sophomore GPA: (a) high school rank, 0.2098; (b) SAT-math, 0.1960; (c) SAT-verbal, 0.1385; (d) special entrance, 0.0566; (e) admission age, 0.0298. Predictors which remained significant when loaded into a multiple prediction equation are listed in order of predictive power with their incremental squared correlation coefficients: (a) high school class rank, 0.2098; (b) SAT-math, 0.0969; (c) admission age, 0.0421; (d) SAT- verbal, 0.0188. The total squared multiple correlation coefficient for the prediction equation was 0.3676. The equation correctly predicted 71.4% of the admission/nonadmission decisions (based on a 2.5 sophomore GPA). Double cross-validation resulted in an average acceptance prediction accuracy of 72.2%. The prediction equation reduced the error of prediction and was recommended for use.

## CHAPTER V

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter includes a brief review followed by the researcher's conclusions based on this research project. Recommendations for further research are also included.

#### PREDICTING ACADEMIC SUCCESS IN COLLEGE: A SCIENTIFIC GUESS

The researcher's first impression from a review of the research and literature concerning the prediction of academic success was one of amazement. How could colleges and universities make admission decisions on the basis of prediction equations which commonly account for less than 30% of the variance involved in achievement? The explanation which points out the lack of anything better leaves something to be desired. A similar experience occurred in relation to evaluation. The fact that a strong question existed about the use of a college GPA as a measurement of aptitude first surprised and later disturbed this researcher. Even more disturbing was the controversy concerning the validity of the GPA as a measure of achievement. One would expect that predicting the future would be a difficult task at best. However, the novice in evaluation usually believes that a strong relationship exists between grades and achievement. The truth is that educators, who should be experts in evaluation, are so inconsistent in their techniques of evaluation that the GPA is riddled with inaccuracy.

The need for educational reform was clear and immediate. However, the ability of the educational community to devise and follow through with meaningful and effective reform remains questionable. The quality of service any profession provides is greatly affected by the balance between the incentives the profession provides to reward its members and the difficulty of obtaining and maintaining membership in that profession. Lawyers and physicians claim that the rewards of their profession are consistent with the extraordinary demands of their respective profession. Educators have been identified more with a fortress mentality than an honest pursuit of excellence with regard to policing their profession. The 2.5 GPA entrance requirement seems a convenient method of attacking the most powerless members of the teaching profession. How many people would question the validity of GPA if it were decided that all current teachers be required to meet this requirement or leave the profession?

The 2.5 grade point average as an entry standard for education majors was suggested as a method of achieving the goal of educational reform. The intention of this standard was clearly to screen out some of the less desirable "low achievers" who had gravitated to education. These unfortunates would somehow manage to graduate from reputable schools of education without achieving competence in "basic skills." The ultimate result of this filtering was to have been the improvement of education via the elimination of these poorly prepared individuals from the ranks. Would raising the entrance requirement to a 2.5 GPA eliminate these people who had somehow tricked educators into giving them passing grades? Perhaps if the standard were enforced at an early point during their

college career, we could catch these weak links while a significant proportion of their GPA is composed of general education requirements--those "basic skills" courses. If students can do well enough in education courses to offset the type of poor performance in general education requirements that reflects a lack of "basic skills," perhaps the weak students are not the greatest problem with the system. Ignoring the potential for increasing grade inflation, how many capable students will be eliminated by the 2.5 GPA entrance requirement? Will students attending schools where a "C" still truly represents satisfactory performance be treated unfairly by this new entrance requirement? Or can we assume that such a place no longer exists?

The questionable relationship between future success and GPA, coupled with the questions about using GPA to evaluate achievement, raise serious doubts about the wisdom of using GPA as an entrance requirement to education. One is left with a simple question concerning the use of the GPA to assess the basic skills necessary to be a good teacher. What are these skills? The ability to read and write? The ability to do enough basic math to average grades? Possession of the sophisticated analytical skills necessary to plan and execute the type of lesson which guarantees the maximum success for each individual in a heterogeneous classroom? Using GPA to measure "basic skills" conveniently circumvents the need to come up with an operational definition of "basic skills." This reflects one of the most basic faults of education: the inability of the field to close toward a definition of quality education. The fear of being held accountable for educational outcomes, combined with the inability to prop-

erly monitor the quality of education, seem to have paralyzed the profession.

The unacceptable measurement error created when GPA is used as an entry criterion would cause the elimination of many capable students along with the less able. Let us admit to ourselves what the evidence clearly shows: Measuring human learning is difficult. We educators cannot agree on how it should be done, yet we seem prepared to use GPAs as a method of improving our profession. The GPA is more an aggregate of our collective inaccuracy than a testament to our accomplishments. Predicting human behavior is inexplicably difficult. Using the GPA to help ensure quality education is an exercise in misplaced professional pride. Delving into this type of scientific soothsaying may be as unfair to our profession as it is to the many capable college students we are preparing to sacrifice to the cause of excellence.

#### A PREDICTION EQUATION

The doubts about the GPA either as a screen (based upon the GPA's poor predictive validity) or as a guarantee of "basic skills" (based upon the GPA's questionable relationship to this unclear concept) created a clear justification for developing a prediction equation which would help identify students at risk of not achieving the 2.5 GPA entrance requirement. Such a prediction equation was successfully developed. A simple advisement aid was developed to help identify students who might need remediation. This document can be found in Appendix A.

A multilevel advisement system was suggested. Intervention strategies were divided into progressively more aggressive levels. Placement in the system was based upon predicted GPA. All students should be made aware of the 2.5 GPA entrance requirement and its implications. A portion of the orientation session should be devoted to making students aware of this criterion. Options for increasing the likelihood of achieving the 2.5 should be introduced at the orientation.

The first level of intervention would include all students who have a predicted GPA between 2.9 and 3.3 (2.5 plus two standard deviations). These students would be advised to limit their first semester course load to 14-15 credit hours. They might also benefit from limiting the courses they take from outside the department to no more than 50% of their total load.

The second level of intervention would involve students with predicted GPAs between 2.5 and 2.9 (2.5 plus one standard deviation). These individuals would be provided with additional strategies to include such suggestions as (a) limiting the number of semester hours attempted in the first semester to 14, (b) considering remedial courses matched to the student's area(s) of weakness (a low SAT-verbal score would suggest remediation in English), and (c) giving each student a written list of the programs the university has available to help students.

The third level of the program was intended to include students with a predicted GPA between 2.5 and 2.1 (2.5 minus one standard deviation). This

would include all steps in the previous levels, with the addition of (a) the suggestion that students limit their course load to 12 semester hours; (b) the requirement that students take at least one remedial course, probably in their weakest area; and (c) the requirement that students participate in at least one university program designed to increase academic achievement.

The final and most aggressive level of the program was intended to include students with a predicted GPA below 2.1 (2.5 minus one standard deviation). This suggestion included (a) the requirement that students limit their course load to 12 semester hours, (b) the requirement that students take remedial courses in both math and English, and (c) the requirement that students participate in at least two university programs designed to increase academic achievement.

#### **RECOMMENDATION FOR FURTHER RESEARCH**

Educational reform is an area of study which warrants much additional study. The most pressing and important need is for good predictors of success as an educator. Unfortunately, this requires that a widely accepted operational definition of quality teaching first be developed. Rather than converging on a single definition of acceptable performance, education has, at best, remained in a state of controversy concerning methodology. The lack of a clear definition of teaching means that there is no clear yardstick for those who wish to evaluate teaching. How can

one honestly predict which students will be good educators when it is not possible to identify what a good educator is?

The prediction equation developed here was intended only for the entering freshmen. Other studies show that a good predictor of college academic success is first-semester GPA. Increasingly accurate prediction equations and remediation strategies could be developed for second- and third-semester students.

The lack of a compatible grade registration system prevented a comparison of the predictors identified in this study to grades in individual courses. A recently implemented records system should make this possible. Two years should provide sufficient time for enough data to be created to make such an investigation possible.

The remediation strategies suggested here should be tested for effectiveness. Again, two years should allow enough time for sufficient data to be generated.

The prediction equation developed here should be updated every year, using the data created by the new students. It is realistic to expect the 2.5 GPA entrance requirement to affect sophomore GPA. The 2.5 GPA requirement may affect the way students and faculty approach the grading issue. This suggests the need for a periodically updated prediction equation.

Predictors should be identified which are correlated with future success in the field of industrial arts/technology education. This suggests, of course, that an operational definition of good teaching in industrial arts/technology education should be developed.

### CONCLUSION

Predicting the future is difficult. It should be approached with this in mind. Educators should be among those most aware of the difficulties of evaluation. Given the difficulty of assessing past performance, predicting future performance should be approached with extreme care. Educational reforms have met with limited success. Any attempt at assessing teaching performance is usually met with skepticism. Is it possible that, in frustration educational reform has turned to those who have no defense--those who are not yet educators?

A prediction equation is one way to limit the error of using the 2.5 GPA as an entrance requirement. Students who are identified as being at risk are given remediation. This provides the motivated student with the opportunity to improve his/her chance of meeting the criterion, hopefully by obtaining a better education.

Much research is still indicated in this area. The most important need for investigation is to find a fair way of identifying and encouraging excellence in potential educators.

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## APPENDIX A

### ADVISEMENT SUGGESTIONS FOR MILLERSVILLE'S IA/TE STUDENTS

#### Instructions

It is likely that less than fifty percent of the future industrial arts/technology education majors at Millersville University will be successful in achieving a 2.5 GPA by the end of their sophomore year. Because this would eliminate many potentially successful teachers, an intervention strategy has been developed. The first step in this intervention is to predict the students' sophomore GPA. This can be done by plugging certain information into a simple algebraic formula and doing a little math. The information required (SAT scores, high school class rank, and age) should be available in the students' records.

It should be noted that this research did not create a system to accurately predict the GPA of students who are over 23 years of age when they are admitted to the university. Most of these students will not have SAT scores or a high school class rank. Since these are important predictors in this study, it is difficult to make an individual prediction about the academic success of these older students. However, eighty percent of these older students will achieve the 2.5 GPA.

The prediction formula was developed using multiple regression and should correctly predict which students will eventually earn a 2.5 GPA, and which

students will not earn the 2.5 GPA, at least seventy percent of the time. Because error was expected, the remediation schedule was designed as a multi-level system driven by the predicted GPA and stratified according to the standard deviation of the prediction equation (confidence levels). In other words, the system is designed to err in the direction of over-remediation. The assumption is that receiving remediation as a result of prediction error is better than not receiving remediation because of prediction error.

The following steps are recommended by the researcher:

1. The advisor should calculate a predicted GPA for each of his or her incoming freshmen before they arrive on campus
2. The advisor should arrange to discuss the implications of the student's predicted GPA in relation to the NCATE criterion (2.5 GPA) before students sign up for classes
3. The advisor should use this information to plan the student's first semester schedule, which is the most critical.
4. The advisor should follow up on the students progress as indicated by the predicted GPA. A student with a predicted GPA of 1.7 will require much more aggressive advisement than a student with a predicted GPA of 3.5.
5. The advisor should use the student's actual GPA in combination with predicted GPA, while also considering past course load, to advise the student on scheduling beyond the first semester.

## Calculations

To calculate the Student's predicted GPA, simply replace the variables with the required values in the equation listed in Figure 18 on page 126 and calculate the student's predicted GPA (see Figure 19 on page 127). Then place the student in the appropriate group as listed in Table 19 on page 128. Determine the advisement strategy appropriate for the student. (This method can only be used with Millersville University students.) Suggestions are listed below.

## Suggested Advisement Strategy

A multilevel advisement system is suggested. Intervention strategies were divided into progressively more aggressive levels. Placement in the system was based upon predicted GPA. Advisors should consider having individual meetings with each of their advisees soon after grades are released each semester.

1. Group 1 (3.4-4.0 predicted GPA): All students should be made aware of the 2.5 GPA entrance requirement and its implications. A portion of the orientation session should be devoted to making students aware of this criterion. The options which are planned for increasing the likelihood of achieving the 2.5 should be introduced at the orientation. Even students who are not identified for remediation may benefit from some of these suggestions.

$$\text{GPA} = -1.3904 + \text{HSCR}(.0096) + \text{SAT-M}(.0018) + \\ \text{admission age}(.1080) + \text{SAT-V}(.0011)$$

Figure 18. Final prediction equation

Student Henry Hammerhead has the following statistics: high school class rank, 58; math SAT, 462; verbal SAT, 410; and age at the time of admission, 19. Replacing the variables with these statistics, the equation looks like this:

$$\text{GPA} = -1.3904 + 58(.0096) + 462(.0018) + 19(.1080) + 410(.0011)$$

$$= -1.3904 + .5568 + .8316 + 2.052 + .451$$

$$= 2.501$$

Figure 19. Using the prediction equation: This fictitious score (2.501) was selected to illustrate a point about placing students in the appropriate group. Taking the score to Table 19 on page 128 reveals that the student could fall into group 3 or 4. Because this prediction is so close to the cutoff for these groups, and because some error is inherent in these predictions, the advisor should exercise discretion when making these close decisions. Perhaps a combination of the suggestions from both groups could be used.

Table 19. Schedule for Selecting a Student's Intervention Group

Predicted GPA	Group #
3.4 - 4.0	1
3.0 - 3.3	2
2.6 - 2.9	3
2.1 - 2.5	4
below 2.1	5

2. Group 2 (3.0-3.3 predicted GPA): These students should be advised to limit their first semester course load to 14-15 credit hours. They might also benefit from limiting the courses they take from outside the department to no more than 50% of their total load.
3. Group 3 (2.6-2.9 predicted GPA): These individuals should be provided with additional strategies, including such suggestions as (a) limiting the number of semester hours attempted in the first semester to 14, (b) considering remedial courses matched to the student's area(s) of weakness (a low SAT-verbal score would suggest remediation in English), and (c) giving each student a written list of the programs the university has available to help students.
4. Group 4 (2.1-2.5 predicted GPA): This level should include all steps in the previous levels with the addition of (a) the suggestion that students limit their course load to 12 semester hours, (b) the requirement that students take at least one remedial course, probably in their weakest area, and (c) the requirement that students participate in at least one university program designed to increase academic achievement.
5. Group 5 (below 2.1 predicted GPA): The final and most aggressive level of the program should strengthen many of the previous suggestions. This level should include (a) the requirement that students limit their course load to 12 semester hours, (b) the requirement that students take remedial courses in both math and English, and (c) the requirement that students participate in at least two university programs designed to increase academic achievement.



## VITA

### EDUCATION

B.S. Virginia Polytechnic Institute and State University, 1979 M.S. Old Dominion University, 1982 Ed.D. Virginia Polytechnic Institute and State University, 1989

### EMPLOYMENT

1979-1980 Woodbridge High School, Woodbridge, VA. 1980-1981 Carver Elementary School, Newport News, VA. 1981-1982 Warwick High School, Newport News, VA. 1982-1983 Old Dominion University, Norfolk, VA. 1983-1987 Hines Middle School, Newport News, VA. 1987- Millersville University, Millersville, PA.

### PERSONAL

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*Joseph M. McCade*