Effect of high school subject patterns upon initial achievement in the curricula of the division of agriculture at the Iowa State College

John Evans Bicknell

Iowa State College

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EFFECT OF HIGH SCHOOL SUBJECT PATTERNS UPON INITIAL ACHIEVEMENT
IN THE CURRICULA OF THE DIVISION OF AGRICULTURE AT THE IOWA STATE COLLEGE

by

John Evans Bicknell

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Major Subject: Vocational Education

Approved:

Signature was redacted for privacy.

In Charge of Major Work

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Signature was redacted for privacy.

Dean of Graduate College

Iowa State College

1950
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I. INTRODUCTION

During the past fifty years the great increase in high school enrollments has increased the demand for a more functional kind of secondary education. As early as 1918, this demand was reflected in the statement of the objectives of education made by a committee of the National Education Association. The aims of education which were stated at that time were good health, vocational efficiency, better home life, good citizenship, sound ethical character, ability to use leisure wisely and command of the fundamental processes. It will be noted that preparation for college entrance does not appear among the foregoing objectives.

Since 1918 the changing social and economic order and changing philosophy of education have been accompanied by several more recent statements of objectives of secondary education. In none of these statements can the purpose of preparation for college entrance be found. Even though the purposes of secondary education have been stated in terms of developing the person into an effective member of a democratic type of society with little concern for further educational experience increasing numbers of high school graduates have been entering colleges and universities.

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To meet the growing demand for college education, some colleges have adopted rigid entrance requirements in terms of prerequisite high school training. Other colleges, however, have adopted the policy of granting admission to all who present a certificate from an accredited high school. A great variety of students seek admission to the latter type of college. However, less than 50% of such entrants ever successfully complete a course of study and receive a degree.¹

From the standpoint of college administration two questions arise in connection with entrance requirements. Are students with any particular high school background more likely to survive and achieve satisfactory marks in one type of college course than they are in others? Is there a disproportionate number of students destined for college failure concentrated in any particular high school background group?

From the standpoint of the high school student, one of two questions arises depending upon the definitions of his educational aims. If he has definitely decided to seek a college education in a certain curriculum is there any pattern of subjects in high school which will give a better preparation for college than will any other?

If he is not sure of the college course which he would like to take, or if he is not at all sure as to whether he wants to go to college at all will any particular high school course of study handicap him if he should decide to continue his education in some specific college curriculum?

No one piece of research could settle all of the foregoing questions. It is the purpose of the present study to explore the relationship between initial success in a college of agriculture and the various types of high school background presented by the students.

When is a student successful in college? Is college success limited to only those who complete a course of study and reach a degree? Questions such as these are difficult to answer. It is conceivable that a student might be eminently successful in his agriculture subjects and yet never complete a degree because of his inability to pass a single course in some basic science. Or a student who was dismissed for poor scholarship may have benefited in terms of personal adjustment. For the purposes of this study, achievement is defined as (1) honor point ratio earned in first-quarter agricultural subjects, (2) mark earned in first-quarter chemistry, and (3) persistence beyond the freshman year. No attempt is made here to evaluate college achievement in terms of intangible factors such as personal satisfaction and character or personality development.
It will be noted that the criteria here chosen are useful in evaluating the various high school patterns in only one respect, that of preparation for college study. It should be kept in mind that it is not the purpose of this study to evaluate the various high school patterns in terms of the objectives for which they were designed.
II. REVIEW OF LITERATURE

The use of psychological test results in the prediction of college success has been the subject of a great many studies during the past 30 years.

Harris\(^1\) reviewed the studies reported prior to 1930. He classified 147 studies according to the factors being related to college success. They were attitudes, study habits, personality characteristics and traits, interests and recreations, extracurricular activities, sports, fraternity membership, subjects and majors, occupational choice, sex, race, physical factors, social background, economic status, home background, number of siblings, and school background.

Harris called attention to the lack of agreement and, in many cases, to contradictory conclusions drawn in these reported studies. As an example, he noted that Lloyd-Jones concluded that students from large high schools obtain higher college marks than do students from small high schools, whereas Vogt concluded that size of high school had no bearing on degree of student achievement. Harris criticised the studies on two counts. (1) When studying the relationship of subjects and achievement and the relationship of other

\(^1\)Harris, Daniel. The Relation of College Grades to Some Factors Other Than Intelligence. Archives of Psychology. 131. July 1931.
factors to achievement no control on intelligence had been used.
(2) There was lack of application of appropriate statistical
tests of significance.

Since 1930 a very great many studies of the relation of
various factors to academic achievement have been carried out.
Harris\(^1\) reported 328 studies which had been made between 1930 and
1937. Durflinger\(^2\) reviewed the literature which had been written
on college success between 1934 and 1943.

It was noted that research studies declined in number during
the war period, probably due to atypical student bodies and the
preoccupation of research workers with the war effort. An inspection
of the titles\(^3\) of educational research in progress by candidates
for the doctorate in American graduate schools suggests that research
in this area is again under way. No attempt is here made to review
all of the studies dealing with the prediction of college student
achievement.

The studies of college success here reviewed may be grouped into
two main classifications according to the criterion of achievement
adopted. Many studies define achievement in terms of a composite

\(^1\)Harris, Daniel. Factors Affecting College Grades - A Review of
the Literature 1930-1937. Psychological Bulletin. 3:125-166. March
1940.

\(^2\)Durflinger, Glenn W. The Prediction of College Success - A
Summary of Recent Findings. Journal of the American Association of
Collegiate Registrars. 19:68-78. October 1943.

\(^3\)Good, Carter V. Doctors' Dissertations Under Way in Education,
average of all college marks whereas other studies define achievement as average marks in a particular area or course in college.

The foregoing main groups may be further divided into those studies in which the predictive values of various factors were tested and those studies in which the college achievements of two or more groups of students were compared. In the latter type of study the pairing of students or the equating of the groups on the basis of some of the factors known to be related to academic achievement was the usual procedure.

A. General College Achievement Prediction Studies

A study by Lauer and Evans¹ is typical of the better early predictive studies. They selected by random sampling a group of 492 students from the 1800 freshmen who entered the Iowa State College in 1926. They drew the sample roughly in proportion to the number of freshmen who were registered in each division of the college. Each of the factors of intelligence, high school average and high school marks in English, mathematics and history was correlated with average college marks. Multiple correlations of the various factors with college marks were calculated. Finally, partial correlations were calculated for the various factors with college marks.

They concluded that (1) English achievement is the factor most closely related to intelligence; (2) high school mathematics is the best single subject for the prediction of college achievement, but that high school average is slightly better; the coefficients of correlation were .46 and .48 respectively; (3) intelligence alone correlated .42 with college achievement. A multiple correlation of high school average and intelligence with college achievement of .55 was obtained. A partial correlation of high school average with college achievement of .38 was obtained. By correlating the college marks made in each of several successive quarters with the high school factors and intelligence they concluded that as the student proceeds in college the relationship between high school achievement and college achievement decreases and between college achievement and intelligence increases.

Many other studies were made of the predictive value of the various high school subjects on college achievement. Clark¹ studied the records of 2613 students at Northwestern University and concluded that Latin had value for the prediction of college achievement.

Nelson² studied the records of 2000 students at Iowa State Teachers College and concluded from his study that foreign language

had value for the prediction of college achievement. In neither of these two preceding studies was intelligence rating for the students controlled. Douglass, on the other hand, used intelligence as a control factor when he studied the achievements of 387 students at Oregon University. He correlated their achievement in college with the number of units of high school credit in the various high school subjects taken by the students. He reported that zero-order correlations of from -.04 for the social sciences to .17 for the foreign languages with college achievement were found. However, when the students' scores upon the American Council on Education Psychological Examination were used as a control factor, partial correlations of from -.12 for social sciences to .11 for vocational subjects were found. The correlation of foreign languages was reduced to .05. He concluded that amounts of the various high school subjects taken by the students bore no relation to achievement in college.

In 1932, Douglass again reported the foregoing study and reviewed the literature which had been reported on the effect of high school subjects upon college achievement up until 1932. From the conclusions reached by other investigators and from the results of his own study,


Douglass concluded that a great many very good students have been barred from college through unjustifiable entrance requirements. Consequently, he recommended that students be admitted to college on the basis of aptitude rather than upon a particular type of college preparatory course of study.

Whelden\(^1\) studied five successive classes at Yale University and reported that greater quantities of Latin taken in high school or privately before entering college caused college grades to be much improved in areas where identical or similar elements were present. He cautioned, however, that there was no virtue in a study of Latin as a mental discipline.

A study similar to that made by Douglass at Oregon was made by Hammer\(^2\) in which he correlated the success of 861 University of Iowa freshmen in their first year courses with the number of units of high school credit which they had taken in the various subject fields. He concluded that college success was not significantly related to pattern of high school subjects and that an accumulation of credit in a high school subject field had no relation to college success in that field. When he controlled upon intelligence scores by use of partial correlation, he concluded that the relation of Latin and foreign language study which had been noted by other investigators

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was more easily explained in terms other than the inherent value of the subjects as determiners of college success.

Concerned about the low percentage of the graduates of the College of Education at the University of Minnesota who were placed in jobs, Patterson\(^1\) made a study of the relation of 17 factors to the College of Education achievement of 538 students. Included in the 17 factors were achievement in 5 high school subjects, number of units in three high school subject matter areas, i.e., social sciences, natural sciences, and foreign language, high school average and rank, college aptitude tests, Miller's Analogies test and age at time of entering. Zero-order and multiple correlations were calculated, linear multiple regression equations were developed and used to make predictions of college marks. The predicted marks were compared with those actually made by the students. It was found that high school averages and Miller's Analogies Test were the best single predictors with correlations of .47 and .45 respectively on College of Education marks. The highest multiple correlation was .55 using the Analogies test, high school averages and previous college marks. The number of semester units in the various subject areas correlated substantially zero with College of Education achievement.

\(^1\)Patterson, Dale O. The Relationship Between Certain Factors and Scholastic Success in the University of Minnesota College of Education. American Association of Collegiate Registrars. 12:191-201. April 1937.
The predictive value of high school grades has been acknowledged by many of the researchers in the field. Adams, Wagner, and Dressel all conducted similar studies in different parts of the country. Adams reported that high school achievement was the best single predictor of college achievement. Wagner used the results of the New York State Regents Examination and found that it was the best single predictor of college success. The results of the standard examination used by Wagner avoided the great variability in high school averages which were noted by Dressel. Even though great differences in marking standards in different high schools were noted, Dressel found high school marks to be the best predictors of college achievement with a correlation of .55.

Patterson, in 1937, reported the use of a multiple regression equation for the prediction of academic achievement. A further study to determine the effectiveness of a five-factor equation was made by Leaf in which he developed a regression equation for predicting

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4Patterson, Dale O. op. cit. p. 192.

the first year achievement of college students using the high school averages, American Council on Education Psychological Examination score, Iowa English Aptitude Examination score and Iowa High School Content Examination Score. The equation was developed from data from the records of 97 freshman students at LaSalle-Peru-Oglesby College at LaSalle, Illinois, and was used to predict the marks of each of 97 different students. He found that predicted marks correlated .78 with the actual marks.

In 1943 Durflinger\(^1\) reviewed the literature which had been written on the prediction of college success in the period between 1934 and 1943. He organized his review according to the type of predictor used by the investigator. The main headings were general aptitude tests, general achievement tests, personality or trait tests, high school achievement, sex differentials and a combination of variables.

Durflinger reported that the median correlation between aptitude and college success as reported by the various investigators was .45 in the late 20's and .52 in 1943. This increase was considered to have been due to the use of improved tests and the tendency for teachers to take intelligence into account when assigning marks and to the increasing use of objective examinations in college which are much more similar to intelligence tests than were the old types of

\(^1\)Durflinger, Glenn W. *op. cit.* pp. 68-78.
essay tests. He reported that general achievement tests such as the Iowa High School Content Examination were coming in for more and more use in the prediction studies. It was indicated that personality and trait tests had come in for some use, however they had a very low relation to achievement as indicated by coefficients of correlation of from -0.09 to 0.15. Writers were agreed that high school marks were the best single predictor of college success. Multiple correlations of from 0.55 to 0.83 between intelligence with high school average and college success were reported. He indicated that studies made of particular groups showed greater success in predicting college achievement than did studies where no stratification was made.

In 1946 Borow\(^1\) pointed out that despite recent improvement of tests and the development of more refined statistical techniques, great inaccuracies still existed in the prediction of college success. Coefficients of multiple correlation that were reported were considered very high if they reached 0.77. The reasons for inaccuracies of prediction according to Borow were (1) the unreliability of the predictive instruments, (2) the unreliability of the index to be predicted and (3) the factors such as adjustability to college environment, study

habits, industriousness, etc. which were difficult to isolate and measure, but which are known to be related to college success. The investigations reviewed by Borow which had attempted to measure the influence of the foregoing nonacademic factors were not in agreement about their relation to achievement, probably due to differences in definition of the factors and to the unstandardized means of collecting and reporting the data.

Borow concluded that

In summary it may be said that the heightened accuracy of academic prognostic work rests upon the continuing improvement in institutional grading methods, upon the development of even more searching ability tests and lastly, I think most significantly, upon the introduction of carefully devised measures of the non-intellectual factors upon college achievement.¹

Ashmore² conducted a study to ascertain whether achievement in certain subjects in high school could be used for the subsequent prediction of success in Eastern Kentucky State Teachers College. He used zero-order, multiple and partial coefficients of correlation as techniques. He concluded that high school achievement was a better predictor of first semester success than first semester achievement was for the prediction of second semester success. High school


English was the best single predictor of college success among the high school subjects, closely followed by high school science. The multiple coefficient between a two-factor prediction made up of high school English marks and intelligence scores on college achievement was .85.

An attempt was made by Minor\(^1\) to determine the predictive value of the nine areas of interest as revealed by the Kuder Preference Record. He found that four of the nine interests were significantly related to the college achievement of 260 freshman engineers. The interests which were significantly related to average achievement were

- Computational \( r = .20 \)
- Scientific \( r = .19 \)
- Artistic \( r = -.11 \)
- Social Service \( r = -.14 \)

A multiple regression equation involving all nine scores from the Kuder test yielded a multiple coefficient of correlation of .26, which was significant for 260 cases. A regression equation involving the score on the American Council on Education Psychological Examination, high school average marks and the score on the Owens-Bennett Test of

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\(^1\)Minor, William T. Usefulness of the Kuder Preference Record For Predicting Academic Success of Iowa State College Engineering Freshmen. Unpublished M. S. Thesis. Iowa State College. 1947.
Mechanical Comprehension yielded a multiple correlation of .61. When interest scores for each Kuder area were added to the foregoing equation it was found that no combination would give a significant advantage for prediction over the predictive value of the original three factor equation. Minor concluded that the Kuder interest scores were of little value in predicting college achievement.

For purposes of his study, Minor assumed that any existing relationship between interest and achievement was linear. Miller\(^1\) made this linear assumption a hypothesis and tested the hypothesis of linearity by noting if a significantly better prediction could be made by using a quadratic equation with the same 260 students as in the Minor study. With this he was unable to disprove a linear relationship.

A number of writers have expressed the value of a fairly accurate prediction of college success at the early high school level. Such prediction would be of value to the guidance function of education.

Thoman\(^2\) reported a study made of the records of 603 students


who had taken the 1939 and 1944 editions of the American Council on Education Psychological Examination during their junior or senior year in high school and who had entered the University of Illinois between the spring semester of 1945 and the summer semester of 1946. The results of the high school American Council on Education Psychological Examination were correlated with those of the college American Council on Education Psychological Examination and were found to correlate from .67 for junior boys to .83 for senior girls. When the students were classified according to time elapsed between the administration of the college and high school tests no relationship could be found between size of correlations and elapsed times. The correlation between high school American Council on Education Psychological Examination scores and achievement in the first two semesters of college was found to be .40, whereas that for the college level test was found to be .44; the difference was not significant.

Thoman found that by using the total score rather than either the quantitative or linguistic score alone the high school test was for all practical purposes as good a predictor of success as the college test.

To find the best predictors of college success, 324 students who entered Cornell Agricultural College in 1942 as freshmen were
studied.\(^1\) The Ohio State Psychological Test, the Cooperative Natural Sciences Test and the Cooperative Mathematics Test were administered. First semester average marks were used as the criteria. Farm experience and high school averages were the other factors studied. Zero-order, second and third order coefficients of correlation and regression equations were used. The Ohio State Psychological Examination was the best of the test battery, \(r = .513\), as compared with .381 for the Natural Science Test and .310 for the Mathematics Test. High school average was the best single predictor. No advantage was found by including the Mathematics and the Science Tests in the prediction when the Ohio State Psychological Examination was used.

Although farm-reared boys were shown in preliminary studies to be more successful, the farm experience rating used in this study was of no advantage in predicting success for these students in agriculture.

A study which was, from the standpoint of techniques, particularly pertinent to the present study was made by MacRae.\(^2\) MacRae studied the records of 206 engineering students who entered the Iowa


\(^2\)MacRae, John M. Usefulness of the Minnesota Personality Scale For Predicting Achievement of College Engineering Students. Unpublished M. S. Thesis. Iowa State College. 1949.
State College as freshmen in the fall quarter of 1946 and who were on the auxilliary campus at Camp Dodge, Iowa.

Two criteria were used (1) composite first-quarter average marks and (2) whether they returned to school in the fall quarter of 1947.

MacRae tested the hypothesis that certain personality factors, as revealed by the Minnesota Personality Scale, were related to college achievement. The factors used for prediction were (1) five factors of the Minnesota Personality Scale, (2) high school averages, (3) American Council on Education Psychological Examination scores and (4) scores on the Owens-Bennett Test of Mechanical Comprehension. The statistical treatment consisted of linear and quadratic multiple regression to determine the relationship between the predictive factors and achievement. Analysis of regression was used to test the value of each of the personality factors in the regression and to test the advantage of the quadratic regression over linear regression for each of the five personality traits.

The students were classified into two groups, i.e., those that returned to school in 1947 fall quarter and those that did not. Discriminant function technique was used to determine the relationship between each of the five personality factors and the tendency to
drop out of school. The results of the discriminant function
were reported as multiple biserial coefficients of correlation.

Throughout the study intelligence score, high school averages
and mechanical comprehension scores were used as control factors.
With and without control the scores on the five parts of the
personality scale showed very little relation to first-quarter
marks. The factor of emotionality was the only one which appeared
to be related to achievement in a nonlinear manner.

B. General College Achievement Comparative Studies

In 1929, Yates\(^1\) reported that in his review of the literature
he could find no objective studies in which the college performance
of students having the different kinds of high school background
were compared. Yates selected 706 graduates from three universities
and classified them into four groups according to their high school
patterns. The four groups were

1. Classical, which was Latin or Greek centered;
2. Scientific, which was mathematics and science centered;
3. Vocational, those who had had three or more units of a
   vocational subject in high school;
4. General, included everything else.

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\(^1\)Yates, James Anderson. The Types of High School Curriculum
Which Give the Best Preparation for College. Bulletin of the Bureau
The study made by Freemon as reported in the article on the attempts which have been made to predict scholastic success on a nonintellectual basis.

The study made by Freemon has suggested that the effect of the high school curriculum and pattern upon college achievement was negligible and that achievement and aptitude tests have been used to predict scholastic success in high school.

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of 1200 students who had completed one term of work. The 1200 students were grouped on the basis of their decile ranks achieved on the American Council on Education Psychological Examination. The decile rank groups were compared on the numbers dropping out each term, the number on probation and the number completing the degree in more or less than normal time. He then calculated the probability of completing the degree for each decile group.

Freeman concluded that, since the probability of completing the degree course was 50% for the lowest decile group, and only 88% for the highest, selection of students on the basis of an intelligence test alone would be extremely ineffective. He therefore made no attempt to develop a critical score for the American Council on Education Psychological Examination.

On the assumption that college student mortality is a measure of the success of an institution and that any appraisal or reform of the college program should be made in the light of student mortality, McNeely\(^1\) set out to find the answers to the following questions:

1. What proportion of students leaves college before obtaining degrees?
2. What proportion receives degrees in the regular 4-year period?
3. How long do students remain in college? (4) To what extent

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\(^1\text{McNeely, John H. } \text{op. cit. } 1938. \text{ p. 111.}\)
do students transfer to other colleges? (5) To what extent do students who leave college return at a later date? (6) To what extent does the rate of mortality differ for various kinds of colleges? (7) What are the principle causes of mortality? (8) To what extent are personal and environmental factors related to mortality?

Twenty-five universities and colleges cooperated and studied the freshmen who entered in 1931 and 1932 and continued through 1934 and 1935, as well as studying those who dropped out and those who took longer than four years to obtain a degree. Altogether 15,535 students were included. This constituted about 1/16 of the freshman enrollment of all colleges in the United States for the two years.

The extent of mortality ranged from 26.9 to 62.5% for all schools. The mortality rate for private schools was 6% lower than for state supported schools. Men left school in slightly greater numbers than did women. From 13 to 57% of all students received their degrees in four years. The freshman year was the one of greatest mortality with from 22 to 48% of freshmen leaving school. The percentage for leaving school decreased markedly during each succeeding year. Colleges of Home Economics had the highest mortality with 57% leaving; Colleges of Law had the lowest mortality with only 22% dropping out.
Agriculture colleges were high in mortality with 49% dropping out during the 4-year period. In agriculture, the Iowa State College reported 66% dropping out and 58% did not transfer or return. In home economics at the Iowa State College, 65.9% dropped out and 56.2% did not transfer or return.

Dismissal for scholastic failure was the most frequent reason for dropping out. Between 20% and 49% of all students leaving school before graduation were dropped out for academic reasons. Ninety-nine per cent of all students in the lowest achievement decile rank left school, whereas only 26% of all those in the highest achievement decile rank dropped out. The remainder of the dropouts was due largely to financial causes.

McNeely's study is by far the most extensive study of mortality among college students here reviewed. It indicates that when compared with the number of students who drop out of school, only a very small number transfer to another school or return at a later date. It also shows that the vast majority of dropouts are for no other reason than for poor scholarship despite anything which may be said to the contrary.

With references to dropout studies, McNeely stated that students' reasons for dropping out could be classified into two categories;

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tangible reasons such as poor scholarship, disciplinary action, financial difficulty, sickness, etc., and intangible reasons such as inability to adjust to college life, lack of interest in the work, inability to coordinate efforts, etc. He stated that studies must differentiate between these reasons if they are to be useful in forecasting dropouts. It was pointed out that there were two types of mortality, gross mortality or the number that leave in any specific year regardless of whether they transfer elsewhere or return at some later date, and net mortality or the number who leave school and do not go elsewhere or do not return to the same school at a later date. To be of value, McNeely concludes that mortality studies must differentiate between gross and net mortality.

Kauffman¹ made a study of the mortality of home economics students at the Iowa State College in an attempt to discover the reasons for students' leaving school. She reviewed 15 studies which had been made between 1924 and 1944. She reported that gross mortality of from 17 to 72% and net mortality of from 16 to 67% was reported by the various writers. All of the writers were reported to have similar results showing that a marked decrease in the number dropping out occurred from year to year. The most frequent reasons for dropping out

were (1) dismissal for poor scholarship, (2) transfer to other colleges and (3) personal reasons such as sickness or financial difficulty. In her own study Kauffman studied the records of all first-quarter freshman home economics students who entered the Iowa State College in the years 1936-1937 and 1937-1938. She compared the achievement and characteristics of those who had graduated by August 31, 1942. Her results were comparable to the earlier studies. She reported a net mortality of 61% which occurred largely during the freshman year and decreased markedly during succeeding years. The withdrawal group had significantly lower achievement than had the successful group, although extensive overlapping existed. Low academic rating accounted for 66% of all dropouts.

To investigate the usefulness of McNeely's conclusions,¹ Landskov² made a study of the classes of 1939, 1940 and 1941 at the University of Minnesota College of Education. There were 1547 students included in the three classes. Of the total number only 296 had entered as freshman students in 1935, 1936 and 1937, the remainder were added by transfer at a later date.

¹McNeely, John H. *op. cit.* 1940. pp. 121-122.
Of the 296 original freshmen, 37% dropped out during their first year, 13% the second year, 7% the third year and 4% the fourth year. Thirty-one and eight-tenths per cent graduated before the summer of 1945. Of those that dropped out a few transferred to other colleges, but only 41% of the 296 ever received a degree. Landskov concluded that although a few transfers were successful at other schools, the gross mortality data were for all practical purposes as good as the net mortality data in reporting mortality.

The large group who transferred into the College of Education were largely made up of students who came in from other colleges of the University at the beginning of the junior year. These latter do not represent an attrition group, however, because they were largely made up of students who had chosen combined majors.

Due probably to earlier selection the mortality ratio of the latter group was much lower.

For the entire 1547, 32% or 490 dropped out. Fifty, or 1 in every 10 dropouts went to school elsewhere and 33 received degrees.

Landskov concluded that further study was necessary but that survival studies were successful in screening out problem cases.

In 1938 Seyler¹ made a follow-up study of two studies which had been made in 1935 and 1937 at the University of Illinois. Six

thousand two hundred sixty-three students from 658 Illinois high schools were registered as freshmen in September of 1936 and September of 1937. The 658 schools were classified into eight size groups. The scholastic rank of students in the various sizes of high schools was correlated with their average freshman marks. The students were grouped according to the quarter of their high school class in which they graduated. The numbers who received degrees and those that dropped out were calculated for each quartile group. A regression equation which had been developed earlier in several studies was used to predict the achievement of each group. The predicted achievement was compared with the actual achievement. Seyler found that slightly greater achievement was made by the students from small high schools than was made by those from large schools, but the difference was not great enough to warrant an educational guidance program based upon the size of high schools; high school rank was significantly related to success in college \( r = .49 \) to \( .64 \); and prediction can be made with a fair amount of accuracy.

Atkinson¹ compared the college success of 1623 students in four college courses at the State University of Iowa who had had various kinds of high school preparation. He found that foreign language had been taken in high school by a greater number of

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successful students than unsuccessful students in all colleges, however, the difference was not significant. He concluded that if scholastic aptitude is controlled

...the findings of research are not such as to make it inadvisable to encourage a student to follow a major interest in a nonacademic field, even though he may later enter college.¹

Questioning the validity of the assumption that large high schools prepare students better for college than do small high schools, Saupe² studied the records of 1321 freshmen at the University of Missouri. Of the total number studied, 426 were average or in the middle 60% of their class, 356 were superior or in the highest quartile group. The students came from various sized high schools which Saupe classified into 7 size groups.

Among the average and superior students, those coming from small high schools achieved higher marks than did the students from the larger schools with the exception of those students in the College of Agriculture where the small number (25) may have affected the averages. There was no attempt made by Saupe to control upon any characteristics known to be related to college achievement.

¹Ibid., p. 203.

One of the most extensive and widely known of the comparative studies is the so-called Eight Year Study which was made by the Progressive Education Association.¹

To determine whether the graduates from the 30 progressive schools were adequately prepared for college, the 2108 graduates who entered college in 1936, 1937, 1938 and 1939 were matched person to person with similar students from conventional schools. Such factors as scholastic aptitude scores, rank in high school graduating class, socio-economic level, size of and type of home community, extra-curricular activities, etc., were used in pairing.

The criteria of college success were to go beyond the mere consideration of college marks. Interviewers and questionnaires were used to determine the degree of satisfactory adjustment to college, breadth and number of interests, reading habits, extra-curricular activities and others, so that each student was evaluated each year in 60 different areas.

General findings were as follows on a comparison of the 1475 matched pairs and revealed that the Thirty Schools graduates

1. Earned a slightly higher total grade average.
2. Earned higher grade averages in all subject fields except foreign language.

3. Specialized in the same academic fields as did the comparison students.
4. Did not differ from comparison group in the number of times they were placed on probation.
5. Received slightly more academic honors in each year.
6. Were more often judged to be precise, systematic and objective in their thinking.
7. Were more often judged to possess a high degree of intellectual curiosity and drive.
8. Were more often judged to have developed clear or well formulated ideas concerning the meaning of education.
9. More often demonstrated a high degree of resourcefulness in meeting new situations.
10. Did not differ from comparison group in ability to plan time effectively.
11. Had about the same problems of adjustment as the comparison group, but approached their solution with greater effectiveness.
12. Participated somewhat more frequently, and more often enjoyed appreciative experiences in the arts.
13. Participated more in all organized student groups except religious and service activities.
14. Earned in each year a higher percentage of nonacademic honors.
15. Did not differ from comparison group in the quality of adjustment to their contemporaries.
16. Differed only slightly from the comparison group in the kinds of judgment about their schooling.
17. Had a somewhat better orientation toward choice of vocation.
18. Demonstrated a more active concern for what was going on in the world.\(^1\)

A corollary study was made in which the graduates of the six most experimental schools and of the six least experimental schools were compared with their matches. The most experimental group displayed

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\(^1\textit{Ibid.}, \text{ pp. 207-208.}\)
marked advantage over their matches whereas the least experimental
group were no different from their matches.

It was concluded that the experimental school graduates
excelled their matches in all types of college success and that
the advantage increased in proportion to the degree that their high
school had employed experimental procedures.

The implications of this study suggest that a student in high
school should be given that education which is of most value to him
as a person without any thought of whether he will go on to college.

Shortly after the end of World War II, a number of studies in
which the scholastic achievement of veteran students was compared
with the achievement of nonveteran students were made. Welborn\(^1\)
selected a sample of 92 male civilians and a sample of 109 male
veteran students. The two groups were compared on such characteristics
as age, marital status, American Council on Education Psychological
Examination scores. It was found that veterans and civilians were
much alike on all characteristics except age and marital status. The
veterans were an average of 3.5 years older than the civilians and a
greater number were married. The pre-war and postwar scholarship of
veterans was compared. Veterans' scholarship slightly exceeded that
of nonveterans in all areas of study and the postwar achievement of

\(^1\)Welborn, Ernest L. The Scholarship of Veterans Attending a
November 1946.
veterans was greater than their pre-war achievement. The gain in achievement was inversely proportional to the pre-war marks made by the student.

Gowan\(^1\) compared the achievement of 146 veterans with that of 365 nonveterans at the Iowa State College. Using analysis of variance without control he found that the veterans had achieved significantly higher marks than had nonveterans in three succeeding quarters of work. When scholastic ability and scholastic aptitude were controlled by the use of covariance analysis employing high school averages and American Council on Education Psychological Examination scores as control measures the veterans still exceeded the nonveterans. By the use of a questionnaire, Gowan collected the data by which the veterans and nonveterans could be compared on other characteristics. Seven such characteristics were studied. They were social group participation, educational goals, attitude toward grades, time spent in study, attitude toward courses and instruction, attitude toward individual attention in instruction and attitude toward compulsory class attendance.

Except for less social group participation by veterans and more study time per week spent by veterans than by nonveterans, there was little difference found between veterans and nonveterans on any of the foregoing characteristics.

Gowan concluded that college administrative practices need not be modified to meet the needs of veterans.

Lipsett and Smith\(^1\) made a comparison of the veteran and non-veteran withdrawals from the Rochester Institute of Technology during the school year 1946-1947. The percentage of withdrawals for veterans was 8.6% and for the nonveterans 9.4%. The difference was not significant. They could find no significant differences between veterans and nonveterans with respect to the reasons for withdrawing.

To determine whether vocational agriculture as taught in the high school prepared students for entrance into a college curriculum in agriculture, Bicknell\(^2\) studied the records of 337 freshman agriculture students who entered the Iowa State College in the 1946 fall quarter. These freshmen were classified into two groups, i.e., those who had taken vocational agriculture in high school and those who had not.

The criterion of achievement was the first-quarter honor point ratio. He stratified on the basis of military service into veteran and nonveteran groups and by multiple regression made allowances for individual differences such as those reflected by American Council on


Education Psychological Examination scores, and high school averages. He concluded that when achievement was defined as first-quarter averages students who had pursued a vocational agriculture program in high school were significantly at an advantage in college.

C. Specific College Achievement Prediction Studies

A number of studies have been reported in which the relationship and predictive value of various factors upon achievement in specific subject areas have been evaluated. Miller\(^1\) analyzed the records of 260 freshman engineering students who entered the Iowa State College in the fall of 1946. Miller tested the relationship between each of the Kuder interest areas and specific subject marks. He found that computational interest correlated .31 with mathematics course marks; scientific interest correlated .24 with chemistry marks and artistic interest correlated .33 with engineering drawing marks. A multiple regression equation was made up from high school average, American Council on Education Psychological Examination score and score on the Owens-Bennett Test of Mechanical Comprehension for the prediction of the marks made by the students in each subject. The advantage gained by adding each interest score to each equation for prediction was

\(^1\)Miller, Allen D. op. cit. pp. 25-27.
tested by analysis of regression. Miller found artistic interest gave a significant advantage in the prediction of engineering drawing marks. The multiple coefficient of correlation was raised from .39 to .53. The multiple correlation for the prediction of mathematics marks was raised from .51 to .57 by the addition of the computational interest factor. The addition of the scientific interest factor, however, raised the multiple correlation for the prediction of chemistry grades from .60 to only .61.

Miller concluded that caution must be used in interpreting the interests as measured by the Kuder test as indicators of course achievement.

In an attempt to discover the relationship between achievement and certain high school background factors, Snider¹ studied all of the freshmen who had graduated from high school in May or June of 1947 and who continued on to the University of Nebraska in the following fall. He investigated such factors as size of school, high school English teacher's salary, distance travelled by student to university, graduate training of teachers, teachers' subject matter preparation, scholastic aptitude of students and students' credits in specific subject matter areas from high school.

The criteria of achievement were the student's performance on the Nebraska English Classification Examination Form XII, Comparative General Culture Test Form U, Social Science Reading Test and the Nebraska Mathematics Placement Test. Snider's results indicated that the American Council on Education Psychological Examination scores were most highly related to achievement as indicated by correlations of over \( .50 \). Very little or no relationship was found between achievement and the other five factors studied.

D. Specific College Achievement Comparative Studies

A few studies have been conducted during recent years wherein the achievement in a specific course of two or more groups of students was investigated. Of these studies only four are here reviewed. Gamble,\(^1\) Drake,\(^2\) O'Brien,\(^3\) and Carter\(^4\) investigated the effect of the


study of vocational agriculture in high school upon the achievements made by students in beginning poultry husbandry, dairy industry, agricultural engineering and botany by comparing their achievements with those made by a similar group who had not had vocational agriculture. For purposes of control the two groups were stratified according to farm experience.

Analyses of variance without control and analyses of covariance with American Council on Education Psychological Examination scores and first-quarter English marks used as control factors revealed that there were no significant differences between the achievements of the vocational agriculture and the nonagriculture groups in beginning courses in poultry husbandry and dairy industry. However, the vocational agriculture groups were shown to have achieved significantly higher marks in beginning botany and in agricultural engineering than had the nonagriculture groups.

In each of the four studies the conclusion was reached that students who had taken vocational agriculture in high school were not handicapped for college work in the course evaluated.

E. Summary

A study of the literature revealed that researchers dealing with college achievement have advanced many discrepant and often contradictory conclusions. This confusion should not be unexpected
since most of the early investigators made no attempt to use control either by stratification, multiple regression or analysis of covariance.

From 1930 until the present time there seems to have been a gradual improvement in the quality of research reported. However, modern statistical inference with such techniques as analysis of variance, analysis of covariance, discriminant function, etc., although now appearing, has had but little impact upon research dealing with student achievement.
III. METHOD OF PROCEDURE

Among the students who entered the Iowa State College Division of Agriculture during the fall quarters of 1946, 1947 and 1948, there were 997 male students available for this study.

The records of the 997 freshmen were classified into four groups according to the number of high school Carnegie units which they had earned in the various high school subject areas. The four groups consisted of students who had had (1) vocational agriculture high school experience, (2) other vocational high school experience, (3) mathematics-science and (4) general high school experience.

From the high school transcripts it is impossible to determine whether credit in agriculture was earned in a federally reimbursed department of vocational agriculture or in a course in general agriculture. However, Starrak and Kneedy¹ found that there were very few schools offering courses in general agriculture that would allow a student to earn more than 2 units of credit. According to the policy of the State Board for Vocational Education² it is required


that a high school department provide three or more years of instruction to be approved for vocational agriculture. Therefore, all students who presented 3 or more units in agriculture as part of their high school preparation were classified as vocational agriculture students. All students who had earned six or more units in any combination of high school mathematics and science subjects were arbitrarily classified as mathematics-science students. All students who had earned six or more units in vocational subjects including those who had earned less than three units in agriculture and who had not earned six or more units in a mathematics-science combination were arbitrarily classified as other vocational students. All students who did not fall into any of the three foregoing categories were classified as general students.

The four groups were stratified according to the year in which they had entered the Iowa State College and whether they had farm or nonfarm backgrounds. For purposes of this study all students who reported their father's occupation as farmer were classified as having a farm background and all students who reported their father's occupation as other than farmer were classified as having had a nonfarm background, including those that reported their father's occupation in fields related to farming such as county agent, feed or implement dealer.
For each of the students the following data were recorded:
(1) score on the American Council on Education Psychological Examination, (2) final mark earned in freshman English, (3) average marks earned in first-quarter agriculture courses, (4) marks earned in the first course in chemistry, and (5) whether the student returned to school in the fall quarter following the one in which he entered as a freshman.

The objective of this study was to determine which of four types of high school experience best prepared students for college work in agriculture. For purposes of this study, college achievement was defined in three ways (1) as average marks in first-quarter agriculture courses excluding survey and orientation courses, (2) as mark achieved in beginning chemistry and (3) as survival attrition at the beginning of the sophomore year.

Thus three criteria were available for the evaluation of the effectiveness of the four high school patterns.

For the first two criteria, students were stratified on the basis of residence. The test of significance used was the analysis of variance with adjustments for disproportion of frequencies in the subgroups. Then a more sensitive test of significance was made by controlling scores on the American Council on Education Psychological Examination and first-quarter marks in college English. The tests of significance used were analyses of covariance made separately for
farm and nonfarm students to avoid complication as a result of disproportion.

The third criterion, attrition-survival, was tested for significant differences among the high school patterns by chi square. In order to make allowances for differences in student ability as indicated from the control factors, a discriminant function was developed. From this discriminant function, chi square was again computed after adjustment of frequencies was made for differences in student ability among the high school patterns.
IV. ACHIEVEMENT IN COURSES IN AGRICULTURE

One way of defining college achievement is in terms of the average mark attained by students in courses in their major subject. For the purposes of this study, one criterion chosen for evaluating effectiveness of high school pattern was the average of the final marks attained by each student in agriculture courses at the end of the first quarter of the freshman year.

To obtain a sample of sufficient numbers of students for satisfactory analysis, records of students for a three-year period were assembled. Before combining the three years, a test was made to discover if disproportionality existed in the number of students in the various subgroups when classification was made on the basis of high school pattern and year of entrance.

The information needed is shown in Table 1. Chi square was found to be 15.24 which is significant and disproportionality was shown to exist.

Before discarding the idea of combining the three years, the achievement in agricultural courses by year and high school pattern was evaluated. The data are shown in Tables 2 and 3 for farm students.
Table 1
Number of Students by Year and by High School Pattern

<table>
<thead>
<tr>
<th>High School Pattern</th>
<th>Year</th>
<th>1946</th>
<th>1947</th>
<th>1948</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocational Agr.</td>
<td></td>
<td>63</td>
<td>64</td>
<td>61</td>
<td>188</td>
</tr>
<tr>
<td>Other Agr.</td>
<td></td>
<td>41</td>
<td>45</td>
<td>71</td>
<td>157</td>
</tr>
<tr>
<td>Math.-Science</td>
<td></td>
<td>66</td>
<td>87</td>
<td>111</td>
<td>264</td>
</tr>
<tr>
<td>General</td>
<td></td>
<td>135</td>
<td>127</td>
<td>126</td>
<td>388</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>305</td>
<td>323</td>
<td>369</td>
<td>997</td>
</tr>
</tbody>
</table>
Table 2
Agriculture Achievement of Farm Students by Pattern and Year

<table>
<thead>
<tr>
<th>Pattern</th>
<th>1946</th>
<th>1947</th>
<th>1948</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voc.Ag.</td>
<td>52</td>
<td>2.298</td>
<td>59</td>
<td>2.607</td>
</tr>
<tr>
<td>Other Voc.</td>
<td>35</td>
<td>2.301</td>
<td>35</td>
<td>2.113</td>
</tr>
<tr>
<td>Math.Sc.</td>
<td>33</td>
<td>2.168</td>
<td>36</td>
<td>2.461</td>
</tr>
<tr>
<td>General</td>
<td>92</td>
<td>1.985</td>
<td>92</td>
<td>2.054</td>
</tr>
<tr>
<td>Total</td>
<td>212</td>
<td></td>
<td>222</td>
<td></td>
</tr>
</tbody>
</table>
Table 3
Agriculture Achievement by Year and High School Pattern For Farm Students

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unadjusted</td>
<td>Adjusted</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
<td>2.04308</td>
<td>1.72816</td>
<td>.86408</td>
</tr>
<tr>
<td>Pattern</td>
<td>3</td>
<td>17.54685</td>
<td>17.23203</td>
<td>5.74401</td>
</tr>
<tr>
<td>Interaction</td>
<td>6</td>
<td>4.07597</td>
<td>4.39089</td>
<td>731.815</td>
</tr>
<tr>
<td>Within</td>
<td>644</td>
<td>452.0516</td>
<td></td>
<td>.70194</td>
</tr>
</tbody>
</table>

-48-
The nonsignificant values for year and interaction suggested that combining the three years produced no bias when pattern was tested for farm boys in terms of achievement in agricultural courses.

In a similar manner, a test was made of the data for nonfarm students shown in Table 4. The analysis of variance is shown in Table 5. Again the nonsignificant values for year and interaction suggested that disproportionality produced no bias when years were combined for nonfarm students.

Table 4  
Agriculture Achievement of Nonfarm Students by Pattern and Year

<table>
<thead>
<tr>
<th>Pattern</th>
<th>1946</th>
<th>1947</th>
<th>1948</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>N</td>
<td>Mean</td>
</tr>
<tr>
<td>Voc. Ag.</td>
<td>11</td>
<td>2.203</td>
<td>5</td>
<td>1.780</td>
</tr>
<tr>
<td>Other Voc.</td>
<td>6</td>
<td>1.733</td>
<td>10</td>
<td>2.173</td>
</tr>
<tr>
<td>Math.-Sc.</td>
<td>33</td>
<td>2.203</td>
<td>51</td>
<td>1.975</td>
</tr>
<tr>
<td>General</td>
<td>43</td>
<td>2.073</td>
<td>35</td>
<td>1.807</td>
</tr>
<tr>
<td>Total</td>
<td>93</td>
<td>101</td>
<td>147</td>
<td>341</td>
</tr>
</tbody>
</table>
Table 5
Analysis of Variance of Agriculture Achievement of Nonfarm Students
By Year and Pattern

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unadjusted</td>
<td>Adjusted</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
<td>2.21190</td>
<td>2.50960</td>
<td>1.25480</td>
</tr>
<tr>
<td>Pattern</td>
<td>3</td>
<td>8.60473</td>
<td>8.90243</td>
<td>2.96748</td>
</tr>
<tr>
<td>Interaction</td>
<td>6</td>
<td>7.20917</td>
<td>6.91147</td>
<td>1.15191</td>
</tr>
<tr>
<td>Within</td>
<td>329</td>
<td>276.41326</td>
<td></td>
<td>.84016</td>
</tr>
</tbody>
</table>
A further simplification of subsequent analyses could be made if it were not necessary to control upon residence either by stratification or separate analyses. The achievement in agricultural courses by high school pattern and residence is shown in Table 6. To test the significance of the differences among these

Table 6

Agriculture Achievement of Farm and Nonfarm Students by High School Pattern

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Farm</th>
<th>Nonfarm</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>x</td>
<td>N</td>
</tr>
<tr>
<td>Voc. Ag.</td>
<td>160</td>
<td>2.43</td>
<td>28</td>
</tr>
<tr>
<td>Other Voc.</td>
<td>120</td>
<td>2.18</td>
<td>37</td>
</tr>
<tr>
<td>Math.-Sc.</td>
<td>115</td>
<td>2.36</td>
<td>149</td>
</tr>
<tr>
<td>General</td>
<td>261</td>
<td>2.05</td>
<td>127</td>
</tr>
<tr>
<td>Total</td>
<td>656</td>
<td>341</td>
<td>997</td>
</tr>
</tbody>
</table>

eight subgroups an analysis of variance was made, with adjustment for disproportionality,¹ and is shown in Table 7. The significant

Table 7
Analysis of Variance of Agriculture Achievement of Farm and Nonfarm Students by Pattern

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degrees of Freedom</th>
<th>Unadjusted Sum of Squares</th>
<th>Adjusted Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residence</td>
<td>1</td>
<td>11.87090</td>
<td>12.16616</td>
<td>12.16616</td>
<td>16.17</td>
</tr>
<tr>
<td>Pattern</td>
<td>3</td>
<td>25.69417</td>
<td>25.98933</td>
<td>8.66311</td>
<td>11.52</td>
</tr>
<tr>
<td>Interaction</td>
<td>3</td>
<td>.45775</td>
<td>0.16249</td>
<td>0.05416</td>
<td>0.07</td>
</tr>
<tr>
<td>Within</td>
<td>989</td>
<td>744.00502</td>
<td></td>
<td>0.75228</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>996</td>
<td>782.02764</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
difference in agriculture achievement between farm and nonfarm students forced the conclusion that the two groups could not be combined for purposes of subsequent analysis.

Two choices of method were possible. Either the sample had to be stratified on the basis of residence or separate analysis had to be made for farm and nonfarm students.

The former method has the advantage of providing more information from any given number of cases, for both farm and nonfarm students. With disproportionality stratification involves serious difficulties whenever analysis of covariance is undertaken. In the present study, evaluation of high school pattern without making allowances for differences in student ability was indefensible.

Two indicators of student ability were readily available for all students. The scores made on the American Council on Education Psychological Examination and marks achieved in the freshman English course could be used to control upon scholastic aptitude and upon college achievement in other courses, respectively. Because analysis of covariance was required it was decided to evaluate high school pattern separately for farm and nonfarm students.
A. Agriculture Achievement of Farm Students

The analysis of the agriculture achievement of farm students shown in Table 3 yielded a significant F-value of 8.18 for pattern. The foregoing analysis revealed therefore, that when students were stratified by year there were significant differences in agriculture achievement among high school pattern subgroups within the farm residence category.

However, a more sensitive test of the differences in agriculture achievement of farm students with the various types of high school pattern can be had if characteristics known to be related to achievement are controlled. Scholastic aptitude was measured by the American Council on Education Psychological Examination and achievement in other college courses as revealed by freshman English marks are two such characteristics. The data used for the covariance analysis of the agriculture achievement of farm students by high school pattern are summarized in Table 8. The deviation values are shown in Table 9.

To carry out analysis of covariance with American Council on Education Psychological Examination scores and freshman English marks controlled, the usual normal equations were used.

\[ \sum_{i} x_{i} y = a \sum_{i} x_{i}^{2} + b \sum_{i} x_{i} \]
\[ \sum_{i} x_{i} y = a \sum_{i} x_{i} + b \sum_{i} x_{i}^{2} \]
Table 8
Summary of Data for Analysis of Agriculture Achievement of Farm Students
By High School Pattern

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>160</td>
<td>120</td>
<td>115</td>
<td>261</td>
<td>656</td>
</tr>
<tr>
<td>Σx</td>
<td>389.016</td>
<td>261.88</td>
<td>271.51</td>
<td>533.883</td>
<td>1456.289</td>
</tr>
<tr>
<td>Σy</td>
<td>1026.8958</td>
<td>661.9334</td>
<td>741.9395</td>
<td>1277.8418</td>
<td>3708.6104</td>
</tr>
<tr>
<td>Σx²</td>
<td>15875</td>
<td>11640</td>
<td>12461</td>
<td>25018</td>
<td>64994</td>
</tr>
<tr>
<td>Σy²</td>
<td>1,648,417</td>
<td>1,205,302</td>
<td>1,390,301</td>
<td>2,596,838</td>
<td>6,840,858</td>
</tr>
<tr>
<td>Σy¹x</td>
<td>255</td>
<td>189</td>
<td>208</td>
<td>412</td>
<td>1064</td>
</tr>
<tr>
<td>Σy²x²</td>
<td>561</td>
<td>423</td>
<td>496</td>
<td>908</td>
<td>2388</td>
</tr>
<tr>
<td>Σx¹y²</td>
<td>39280.98</td>
<td>26472.76</td>
<td>30375.52</td>
<td>52822.33</td>
<td>148951.59</td>
</tr>
<tr>
<td>Σy¹x²</td>
<td>668.74</td>
<td>471.73</td>
<td>540.57</td>
<td>952.25</td>
<td>2633.29</td>
</tr>
<tr>
<td>Σx¹y²</td>
<td>26718</td>
<td>19801</td>
<td>23365</td>
<td>41778</td>
<td>111662</td>
</tr>
</tbody>
</table>
Table 9
Deviation Values for Analysis of Agriculture Achievement by High School Pattern

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Within Deviation</th>
<th>Within + High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees of Freedom</td>
<td>652</td>
<td>655</td>
</tr>
<tr>
<td>$\Sigma y$</td>
<td>458.1829</td>
<td>475.7177</td>
</tr>
<tr>
<td>$\Sigma x_1$</td>
<td>388364.3</td>
<td>401498.92</td>
</tr>
<tr>
<td>$\Sigma x_2$</td>
<td>657.3499</td>
<td>662.244</td>
</tr>
<tr>
<td>$\Sigma x_1 y$</td>
<td>4356.92</td>
<td>4667.98</td>
</tr>
<tr>
<td>$\Sigma x_2 y$</td>
<td>266.9987</td>
<td>271.2563</td>
</tr>
<tr>
<td>$\Sigma x_1 x_2$</td>
<td>5998.053</td>
<td>6244.902</td>
</tr>
</tbody>
</table>
Where

\[ y = \text{Agriculture achievement deviation score} \]
\[ x_1 = \text{American Council on Education Psychological Examination deviation score} \]
\[ x_2 = \text{Freshman English deviation score} \]

\( a \) and \( b \) are appropriate constants.

Two such equations were desired, one for total variations and one for within pattern variations. Substituting the needed values from Table 9 into the normal equations for the total regression the equations become:

\[
\begin{align*}
4667.981 &= 401498.92a + 6244.902b \\
271.2563 &= 6244.902a + 662.244b
\end{align*}
\]

Solving simultaneously for values of \( a \) and \( b \), the needed regression equation became

\[ y = 0.0058178807x_1 + 0.3525931x_2 \]

The sum of squares for total residuals = \( \Sigma y^2 - (0.0058178807x_1 y + 0.3525931x_2 y) \)

In a similar manner the equations for within regression became

\[
\begin{align*}
4356.92 &= 38364.30a + 5998.053b \\
266.9987 &= 5998.053a + 657.3499b
\end{align*}
\]

Solving simultaneously for values of \( a \) and \( b \) the needed regression equation became

\[ y = 0.0057567925x_1 + 0.35364596x_2 \]
The sum of squares for within residuals

$$\sum y^2 - (0.0057567925x_1y + 0.353645962x_2y)$$

The analysis of covariance of agriculture achievement by high school pattern for farm students is shown in Table 10.

Table 10

Covariance Analysis of Agriculture Achievement of Farm Students by High School Pattern With ACE and English Achievement Controlled

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Deviation</td>
<td>653</td>
<td>351.6157</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Pattern Deviation</td>
<td>650</td>
<td>338.6780</td>
<td>.52104</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>3</td>
<td>12.9377</td>
<td>4.3125</td>
<td>8.277</td>
</tr>
</tbody>
</table>

The F-value of 8.277 with 3 and 650 degrees of freedom is significant. The conclusion was drawn therefore among the farm group that agriculture achievement of students from one or more high school subject patterns is not uniform for the entire group.
To discover which of the high school patterns made the greatest contributions to the previously noted differences, an analysis of covariance was made in which the agriculture achievement of the students in each high school pattern was compared with the achievement of students in all others.

The normal equations for within group and total deviations were developed in the usual manner from the data shown in Table 8. The normal equations, when solved simultaneously, yielded the values for the constants a and b which are shown in Table 11.

Table 11
Regression Constant for Covariance Analysis of the Agriculture Achievement of Farm Students by Individual High School Pattern By All Others

<table>
<thead>
<tr>
<th>High School Pattern</th>
<th>N</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>656</td>
<td>0.0061587740</td>
<td>0.35152507</td>
</tr>
<tr>
<td>Within:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voc. Ag. vs. Others</td>
<td>160</td>
<td>0.0061053665</td>
<td>0.35403765</td>
</tr>
<tr>
<td>Other Voc. vs. Others</td>
<td>120</td>
<td>0.0061551610</td>
<td>0.35149512</td>
</tr>
<tr>
<td>Math.-Sc. vs. Others</td>
<td>115</td>
<td>0.0061035565</td>
<td>0.35132996</td>
</tr>
<tr>
<td>General vs. Others</td>
<td>261</td>
<td>0.0056596340</td>
<td>0.35225087</td>
</tr>
</tbody>
</table>

The four analyses of covariance are shown in Table 12. The F-value of 6.70 is required for significance with 1 and
652 degrees of freedom. Therefore, it may be concluded that the agriculture achievements of farm students with vocational agriculture and with general high school patterns are significantly different. The agriculture achievements of farm students with other vocational and with mathematics-science high school patterns are not significantly different from that which could be expected on the basis of their scholastic aptitude and English achievement. As an indication

### Table 12

Analysis of Covariance of Agriculture Achievement of Farm Students Each Pattern by All Others

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Variation</td>
<td>653</td>
<td>351.6157</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voc. Ag. vs. Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within</td>
<td>652</td>
<td>341.35006</td>
<td>.523543</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>1</td>
<td>10.26564</td>
<td>10.26564</td>
<td>19.608</td>
</tr>
<tr>
<td>Other Voc. vs. Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within</td>
<td>652</td>
<td>351.58344</td>
<td>.53924</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>1</td>
<td>.03226</td>
<td>.03226</td>
<td>.0598</td>
</tr>
<tr>
<td>Math.-Sc. vs. Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within</td>
<td>652</td>
<td>351.5862</td>
<td>.53924</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>1</td>
<td>.0295</td>
<td>.0295</td>
<td>.0547</td>
</tr>
<tr>
<td>General vs. Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within</td>
<td>652</td>
<td>343.12565</td>
<td>.52627</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>1</td>
<td>8.49005</td>
<td>8.49005</td>
<td>16.132</td>
</tr>
</tbody>
</table>

-60-
of the effectiveness of the American Council on Education Psychological Examination scores and English marks as control factors a multiple correlation of .51 was found.

To determine the effectiveness of the various high school patterns as preparation for college courses in agriculture it was necessary to determine whether the differences in agriculture achievement previously discovered among high school patterns constitute advantages or disadvantages and to measure the degree of advantage or disadvantage thus found in the sample studied.

Such an evaluation could be made by the comparison of the mean agriculture achievement of each high school pattern group with the mean agriculture achievement of all other students after the means have been adjusted for differences in scholastic aptitude and scholastic ability.

An adjustment for the mean agriculture achievement of each group may be determined if it is assumed that the differences in agriculture achievement which were due to differences in scholastic aptitude and scholastic ability could be predicted through the use of a regression equation of the form

$$\text{Mean adjustment} = a(\bar{x}_{\text{group}} - \bar{x}_{\text{general}}) + b(\bar{x}_{2\text{group}} - \bar{x}_{2\text{general}})$$

a and b are the constants for within group regressions which are shown in Table 11.
The adjustments, thus determined, may then be subtracted from the mean agriculture achievement of the appropriate group. Thus the differences in the agriculture achievements of the groups to be compared which are due to differences in scholastic aptitude and scholastic ability may be equated.

The vocational agriculture and the general high school pattern groups were the only ones shown by the previous analyses to be significantly different in agriculture achievement. The mean agriculture achievement and the adjusted mean agriculture achievement of these groups are shown in Table 13.

Table 13

Mean Agriculture Achievement of Farm Students With Vocational Agriculture and General High School Patterns

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Unadjusted</th>
<th>Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voc. Ag.</td>
<td>160</td>
<td>2.431</td>
<td>2.440</td>
</tr>
<tr>
<td>All Others</td>
<td>496</td>
<td>2.152</td>
<td>2.149</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>.280</td>
<td>.292</td>
</tr>
<tr>
<td>General</td>
<td>261</td>
<td>2.046</td>
<td>2.076</td>
</tr>
<tr>
<td>All Others</td>
<td>395</td>
<td>2.335</td>
<td>2.315</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>-.290</td>
<td>-.238</td>
</tr>
<tr>
<td>Total</td>
<td>656</td>
<td>2.220</td>
<td>2.220</td>
</tr>
</tbody>
</table>


It can be seen that when the groups were equated on scholastic aptitude and scholastic ability, the vocational agriculture group made an agriculture average nearly 3/10 of a letter grade greater than the average for all other groups combined and the general group made an agriculture average of nearly 1/4 of a letter grade less than the average for all other groups combined in the sample studied.

It may be concluded, therefore, that there are factors other than scholastic aptitude and scholastic ability in operation which caused the agriculture achievement of students with vocational agriculture high school patterns to be greater and the agriculture achievement of students with general high school backgrounds to be less than the average agriculture achievement of all others.

B. Agriculture Achievement of Nonfarm Students

The analysis of variance of the agriculture achievement of nonfarm students classified by high school pattern is shown in Tables 4 and 5. The value of $F$ for pattern of 3.53 is significant. On the basis of this evidence it appears that there are factors in operation which cause some high school patterns to be more effective than others as preparation for college agriculture for nonfarm students. However, when scholastic aptitude and scholastic ability are controlled upon through covariance analysis a more sensitive test was had. The data used for the covariance analysis of agriculture achievement of nonfarm students by high school pattern are shown in Table 14.
Table 14

Summary of Data for Analyses of Agriculture Achievement of Nonfarm Students by High School Pattern

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Voc. Ag.</th>
<th>Other Voc.</th>
<th>Math.-Sc.</th>
<th>General</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>28</td>
<td>37</td>
<td>149</td>
<td>127</td>
<td>341</td>
</tr>
<tr>
<td>( \Sigma X )</td>
<td>60.45</td>
<td>69.03</td>
<td>318.698</td>
<td>230.39</td>
<td>678.568</td>
</tr>
<tr>
<td>( \Sigma X^2 )</td>
<td>153.0653</td>
<td>158.8533</td>
<td>821.315344</td>
<td>511.5117</td>
<td>1644.74564</td>
</tr>
<tr>
<td>( \Sigma X_1 )</td>
<td>2864</td>
<td>3737</td>
<td>1641</td>
<td>12402</td>
<td>35414</td>
</tr>
<tr>
<td>( \Sigma X_2 )</td>
<td>303,028</td>
<td>392,761</td>
<td>1,877,705</td>
<td>1,269,270</td>
<td>3,842,764</td>
</tr>
<tr>
<td>( \Sigma X^2_1 )</td>
<td>39</td>
<td>55</td>
<td>279</td>
<td>197</td>
<td>570</td>
</tr>
<tr>
<td>( \Sigma X^2_2 )</td>
<td>81</td>
<td>121</td>
<td>673</td>
<td>439</td>
<td>1314</td>
</tr>
<tr>
<td>( \Sigma Y )</td>
<td>6290.89</td>
<td>7119.38</td>
<td>36203.53</td>
<td>23059.50</td>
<td>72673.30</td>
</tr>
<tr>
<td>( \Sigma Y^2 )</td>
<td>95.12</td>
<td>119.06</td>
<td>662.42</td>
<td>404.39</td>
<td>1280.99</td>
</tr>
<tr>
<td>( \Sigma Y_1 )</td>
<td>4142</td>
<td>6064</td>
<td>31,661</td>
<td>20,387</td>
<td>62,254</td>
</tr>
</tbody>
</table>
Table 15
Deviation Values for Analysis of Agriculture Achievement of Nonfarm Students by High School Pattern

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Within Pattern Deviation</th>
<th>Total Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees of Freedom</td>
<td>337</td>
<td>340</td>
</tr>
<tr>
<td>$\sum y^2$</td>
<td>285.8344</td>
<td>294.4391</td>
</tr>
<tr>
<td>$\sum x_1^2$</td>
<td>153,758.62</td>
<td>164,901</td>
</tr>
<tr>
<td>$\sum x_2^2$</td>
<td>349.91634</td>
<td>361.2141</td>
</tr>
<tr>
<td>$\sum x_1 y_1$</td>
<td>1918.003</td>
<td>2201.73</td>
</tr>
<tr>
<td>$\sum x_2 y_2$</td>
<td>140.04642</td>
<td>146.7268</td>
</tr>
<tr>
<td>$\sum x_1 x_2$</td>
<td>2742.7872</td>
<td>3057.58</td>
</tr>
</tbody>
</table>
The deviation values obtained are shown in Table 15.

The analysis of covariance of agriculture achievement of nonfarm students by high school pattern is shown in Table 16.

Table 16

Covariance Analysis of Agriculture Achievement of Nonfarm Students By High School Pattern With AGE and English Achievement Controls

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Deviation</td>
<td>338</td>
<td>228.2125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With Pattern Deviation</td>
<td>335</td>
<td>224.6967</td>
<td>.67074</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>3</td>
<td>3.5158</td>
<td>1.1719</td>
<td>1.747</td>
</tr>
</tbody>
</table>

The F-value of 1.747 with 3 and 335 degrees of freedom does not reach the five per cent level of significance. Therefore, by the techniques here used, no differences in the agriculture achievement of the nonfarm students from the various high school patterns could be demonstrated.

The differences which were previously reported in the analysis without control on American Council on Education Psychological Examination scores or English achievement may largely be accounted for by differences among the high school pattern groups in scholastic
aptitude and scholastic ability. As an indication of the effectiveness of the control factors used a multiple correlation of .497 was found.

C. Agriculture Achievement Within High School Patterns by Residence

In the earlier analysis in which a comparison of the agriculture achievement of farm and nonfarm students, when classification by high school patterns was made, it was found that there was a significant difference in the achievement of farm and nonfarm students.

To determine whether there was a significant difference between the agriculture achievement made by farm and nonfarm students within each high school pattern an analysis of variance was made. A further analysis in which scholastic aptitude and scholastic ability were controlled upon through covariance analysis was carried out. The results of these analyses are summarized in Table 17.

Table 17
Summary of Analyses of Agriculture Achievement of Farm and Nonfarm Students in Each High School Pattern

<table>
<thead>
<tr>
<th>High School Pattern</th>
<th>Farm N</th>
<th>Mean</th>
<th>Nonfarm N</th>
<th>Mean</th>
<th>Uncontrolled Analysis of</th>
<th>ACE and Cont. Cov. F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voc. Ag.</td>
<td>160</td>
<td>2.431</td>
<td>28</td>
<td>2.159</td>
<td>2.786</td>
<td>2.647</td>
</tr>
<tr>
<td>Other Voc.</td>
<td>120</td>
<td>2.182</td>
<td>37</td>
<td>1.866</td>
<td>3.648</td>
<td>4.535</td>
</tr>
<tr>
<td>Math.-Sc.</td>
<td>115</td>
<td>2.361</td>
<td>149</td>
<td>2.139</td>
<td>2.485</td>
<td>7.098</td>
</tr>
<tr>
<td>General</td>
<td>261</td>
<td>2.046</td>
<td>127</td>
<td>1.814</td>
<td>6.356</td>
<td>7.977</td>
</tr>
</tbody>
</table>
The F-values for agriculture achievement of farm and nonfarm students found through analysis of variance for the vocational agriculture, other vocational and the mathematics-science patterns were not significant. The F-value found for the general pattern was significant. When scholastic aptitude and scholastic ability were controlled by covariance the F-value for the vocational agriculture pattern group was found to be nonsignificant, whereas the F-values obtained for other high school pattern groups were significant.

It would appear that little or no relation exists between achievement in college and farm experience if a student has received high school training in vocational agriculture. However, farm experience seems to be related to the agriculture achievement of the students within each of the other high school pattern groups. It was necessary, therefore, to evaluate the achievement of farm and nonfarm students with other vocational, mathematics-science and general high school pattern backgrounds. The evaluation was carried out by adjusting the mean achievements made by the farm and nonfarm students in each of the three high school pattern groups for differences in scholastic aptitude and scholastic ability.

The evaluation of the agriculture achievement of the farm and nonfarm students in three high school pattern groups is shown in Table 18. The mean agriculture achievement for all students in each
high school pattern was subtracted from the adjusted mean achievement of the farm and nonfarm groups from which it was composed.

Table 18

Actual and Adjusted Mean Agriculture Achievement by Residence and High School Pattern

<table>
<thead>
<tr>
<th>Residence</th>
<th>High School Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Other Voc.</td>
</tr>
<tr>
<td>N</td>
<td>120</td>
</tr>
</tbody>
</table>

Average Achievement

Farm

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted</th>
<th>Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.182</td>
<td>2.361</td>
</tr>
<tr>
<td></td>
<td>2.178</td>
<td>2.375</td>
</tr>
</tbody>
</table>

Nonfarm

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted</th>
<th>Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.866</td>
<td>2.139</td>
</tr>
<tr>
<td></td>
<td>1.852</td>
<td>2.128</td>
</tr>
</tbody>
</table>

Total

|        | 157        | 264      | 388     |
| Mean   | 2.106      | 2.236    | 1.970   |

The mean differences, thus determined, are shown in Table 19.

It may be seen that in each of the three high school pattern groups the agriculture achievement of the farm students exceeded that of the nonfarm students. Within the other vocational pattern group the average agriculture achievement of the farm students exceeded that of the nonfarm students by nearly 1/3 of a letter grade.
Within the mathematics-science pattern group the average agriculture achievement of the farm students exceeded that of the nonfarm by nearly 1/4 of a letter grade. Within the general pattern group the agriculture average of the farm group exceeded that of the nonfarm group by nearly 1/4 of a letter grade.

Table 19
Mean Differences in Agriculture Achievement by Residence and High School Pattern

<table>
<thead>
<tr>
<th>High School Pattern</th>
<th>Farm</th>
<th>Nonfarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Vocational</td>
<td>.0704524</td>
<td>-.2555682</td>
</tr>
<tr>
<td>Mathematics-Science</td>
<td>.1289289</td>
<td>-.10722451</td>
</tr>
<tr>
<td>General</td>
<td>.0745268</td>
<td>-.1533668</td>
</tr>
</tbody>
</table>

It is possible that the higher agriculture subject marks achieved by the farm students in all high school pattern groups except the vocational agriculture pattern group may be due, in part, to a carry-over of the knowledge and skills attained through farm experience into the first quarter of college. A corollary of this possibility is that high school training in vocational agriculture equated the farm and nonfarm students on the basis of knowledge and skills which could
be carried over into the first quarter of college work in agriculture. Another possible explanation of the differences in agriculture achievement here noted is that contacts with agriculture through farm experience or through high school training in vocational agriculture stimulated an interest in agricultural subjects in the students which resulted in a greater motivation of those students during their first quarter in college.

Another hypothesis which may account for the differences here noted is that a disproportionate number of students who were greatly interested in agriculture chose the vocational agriculture program in high school. No attempt has been made to evaluate these hypotheses.
V. ACHIEVEMENT IN CHEMISTRY COURSE

One of the factors which may be closely related to the college success or failure of an individual student in an institution such as the Iowa State College is his ability to succeed in courses in the basic natural sciences. If it can be assumed that a student's achievement in his first course in college chemistry will give an indication of this ability, then an evaluation of chemistry achievement of the students having the various types of high school pattern background would be of value in determining the pattern effectiveness as preparation for college agriculture.

The elementary course in chemistry given at the Iowa State College is designated as Chemistry 101. Credit in Chemistry 101 may be earned in one of two ways; a student may enroll in Chemistry 101 and complete it in one quarter, or, if it appears that after a three-week trial period, he is in danger of failing, he is given the alternative of continuing in 101 or of taking courses 100A and 100B which cover the same subject matter in two quarters. For this reason the records of students for their first contacts with chemistry include marks in either Chemistry 101 or 100A.

To use chemistry marks as a criterion of achievement it became necessary to assign weightings to the letter mark values for 101 and 100A so that they could be combined. For example, a mark of C in
Chemistry 100A is not the equivalent of a C in Chemistry 101 so that an additive combination of the two would be absurd. One method of weighting might be to multiply each 101 mark by 2 and each 100A mark by 1, thus taking into consideration that 100A covers only about one-half of the subject matter covered in 101. However, to weight the marks in a 2 to 1 ratio ignores, to some extent, the quality of the work done by the student. In order that both the quality of work and the credit hours received could be taken into account an arbitrary 3 to 2 weighting was chosen. Such a weighting was a compromise between ignoring credit hours received or ignoring the quality of work done by the student.

The courses in chemistry are taken by agriculture students at some time during their freshman or sophomore years. Beyond the foregoing there is little uniformity in the time when chemistry is taken. Because of the small numbers of students who entered college in the fall of 1948 who had taken a course in chemistry by the fall of 1949, it was decided to exclude the 1948 group from the analysis of the chemistry achievement. Of the students who entered the Iowa State College Division of Agriculture as freshmen in the fall quarters of 1946 and 1947, 286 had taken a course in chemistry by the beginning of the 1949 fall quarter. The numbers of students and their average, weighted chemistry achievement are shown in Table 20.
It may be seen that some of the high school patterns in the farm group have very few cases. If the farm and nonfarm groups could be combined the sensitivity of further analyses could be increased. In order to test the significance of differences in chemistry achievement between farm and nonfarm students an analysis of variance with multiple classification by residence and high school pattern was made. The basic raw data which were used for all subsequent analyses are summarized in Table 21.

Table 20
Average Weighted Chemistry Achievement by High School Pattern and Residence

<table>
<thead>
<tr>
<th>High School Pattern</th>
<th>Farm</th>
<th>Nonfarm</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>N</td>
</tr>
<tr>
<td>Voc. Ag.</td>
<td>53</td>
<td>4.43</td>
<td>5</td>
</tr>
<tr>
<td>Other Voc.</td>
<td>18</td>
<td>4.28</td>
<td>9</td>
</tr>
<tr>
<td>Math.-Sc.</td>
<td>34</td>
<td>6.35</td>
<td>46</td>
</tr>
<tr>
<td>General</td>
<td>80</td>
<td>4.00</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td>4.58</td>
<td>101</td>
</tr>
</tbody>
</table>
Table 21

Summary of Data for Analyses of Chemistry Achievement

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Farm</th>
<th>Nonfarm</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>53</td>
<td>18</td>
<td>34</td>
</tr>
<tr>
<td>ΣX</td>
<td>235</td>
<td>77</td>
<td>216</td>
</tr>
<tr>
<td>ΣX²</td>
<td>1553</td>
<td>607</td>
<td>1704</td>
</tr>
<tr>
<td>ΣX¹</td>
<td>5236</td>
<td>1834</td>
<td>3799</td>
</tr>
<tr>
<td>ΣX²</td>
<td>89</td>
<td>40</td>
<td>67</td>
</tr>
<tr>
<td>ΣX¹</td>
<td>535851</td>
<td>191056</td>
<td>435085</td>
</tr>
<tr>
<td>ΣX²</td>
<td>189</td>
<td>102</td>
<td>155</td>
</tr>
<tr>
<td>ΣX¹</td>
<td>24101</td>
<td>7919</td>
<td>24574</td>
</tr>
<tr>
<td>ΣX²</td>
<td>416</td>
<td>192</td>
<td>456</td>
</tr>
<tr>
<td>ΣX¹</td>
<td>9001</td>
<td>4124</td>
<td>7566</td>
</tr>
</tbody>
</table>

Y = Weighted Chemistry Marks  
X₁ = ACE Scores  
X₂ = English Marks
The analysis of variance of chemistry achievement by residence and high school pattern is shown in Table 22. The method of adjustment for disproportion was the same as previously employed in the analysis of agriculture achievement by year and residence.

It may be seen from Table 22 that the F-value for residence is not significant. Therefore, no differences in chemistry achievement between farm and nonfarm students could be shown and a combination of the two groups was inferred to be justified.

Table 22

Analysis of Variance of Chemistry Achievement by Residence and High School Pattern

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residence</td>
<td>1</td>
<td>60.3068</td>
<td>6.7883</td>
<td>6.7883</td>
</tr>
<tr>
<td>Pattern</td>
<td>3</td>
<td>389.2339</td>
<td>335.7154</td>
<td>111.9051</td>
</tr>
<tr>
<td>Interaction</td>
<td>3</td>
<td>-43.1520</td>
<td>10.3665</td>
<td>3.4555</td>
</tr>
<tr>
<td>Within</td>
<td>278</td>
<td>3095.919</td>
<td>3095.919</td>
<td>11.1364</td>
</tr>
<tr>
<td>Total</td>
<td>285</td>
<td>3502.308</td>
<td>3502.308</td>
<td></td>
</tr>
</tbody>
</table>
An F-value of 10.05 for pattern is shown in Table 22. This value of F is significant, indicating that when the chemistry marks made by the students with the various types of high school experience are compared employing no control other than on the disproportion among subgroups, there are significant differences in chemistry achievement among high school patterns.

A more sensitive test could be had if characteristics known to be related to student achievement could be controlled upon through covariance analysis.

The covariance analysis with American Council on Education Psychological Examination scores and first-quarter English achievement controlled is shown in Table 23.

Table 23
Analysis of Covariance of Chemistry Achievement by High School Pattern

| Source of Variation | Degrees of Freedom | Residuals | | |
|---------------------|--------------------|-----------|-----------|
|                     | Sum of Squares     | Mean Square | F |
| Total               | 283                | 2699.0280  |          |
| Within              | 280                | 2528.0897  | 9.02889 |
| Total Difference    | 3                  | 170.9383   | 56.9794  | 6.31 |
The F-value of 6.31 with 3 and 280 degrees of freedom is significant. Therefore, it may be concluded that there are differences in chemistry achievement among the students with the various high school backgrounds which cannot be accounted for on the basis of differences in scholastic aptitude or scholastic ability as measured by the control factors employed. As an indication of the effectiveness of English marks and American Council on Education Psychological Examination scores as control factors a multiple correlation on chemistry achievement of .48 was found.

In 1948 Hunter\(^1\) reported that, when scholastic ability and scholastic aptitude were controlled, students who had high school training in chemistry made significantly higher marks in the initial chemistry course in college than those students who had no high school training in chemistry. In the light of Hunter's finding it is possible that the significant differences in chemistry achievement among high school patterns may be largely attributed to the effects of the chemistry courses taken in high school by the mathematics-science pattern group. An inspection of Table 20 reveals that the pattern group showing the greatest difference in average weighted

chemistry marks is the mathematics-science group. The average weighted chemistry marks of the other three pattern groups are not greatly different from each other. To determine whether differences in average weighted chemistry achievement exist among high school pattern groups when the mathematics-science group is excluded an analysis of covariance with control was carried out and is summarized in Table 24.

Table 24
Covariance Analysis of Chemistry by High School Pattern With Mathematics-Science Pattern Excluded

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>203</td>
<td>1906.6558</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Patterns</td>
<td>201</td>
<td>1890.3204</td>
<td>9.40458</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>2</td>
<td>16.3354</td>
<td>8.1677</td>
<td>0.87</td>
</tr>
</tbody>
</table>

The F-value of 0.87 is not significant. Thus no differences in chemistry achievement, as here defined, could be demonstrated among the high school subject area patterns when mathematics-science pattern students were excluded from the analysis. Therefore, the only differences which could be found among the high school subject
pattern groups in chemistry achievement may be attributed to the mathematics-science pattern group.

An inspection of Table 21 reveals that, without control, the chemistry achievement of the mathematics-science group exceeds that of the other groups by a considerable margin. When the mean achievement of the pattern groups was adjusted for differences in scholastic aptitude and scholastic ability the advantage of the mathematics-science pattern group was reduced but yet still remained significant.

To the degree that high school pattern groups can be evaluated in terms of chemistry achievement, the mathematics-science group made greater achievement in chemistry than any of the other groups. In the light of the findings of Hunter it appears that it is possible that the advantage in chemistry achievement attained by the mathematics-science group may be accounted for by the disproportionate number of mathematics-science group students who had taken high school courses in chemistry.

On the other hand, no evidence in this study or in the Hunter study disproves an inference that the mathematics-science pattern is not the desirable characteristic and that the Hunter conclusion of the advantage of high school chemistry may have resulted from his group who had had high school chemistry more often followed a mathematics-
science pattern than did the group who had no high school chemistry.

It was beyond the scope of this study to attempt to identify the cause of the higher level of achievement by the mathematics-science group other than to eliminate variation in the general abilities of students as indicated by general scholastic aptitude and college English achievement.
VI. ATTRITION AND HIGH SCHOOL PATTERN

One indication of the usefulness of any educational program is the attrition-survival ratio. It is well known that a high proportion of college students entering as freshmen fails to later graduate. Many reasons, no doubt, contribute to this attrition, such as (1) failure of the program to meet the needs of students, (2) lack of ability to do the quality and quantity of work demanded by the program, (3) health, (4) economic considerations and many others. The actual reasons for attrition for any given student are difficult to identify with any great degree of accuracy. In many instances, the reasons for attrition are so highly interrelated and simultaneously operative that a student cannot accurately evaluate the reasons for his attrition even if he should be willing to report the true reasons to others.

Although many objections may be advanced against using attrition as a criterion of effectiveness of the high school pattern, it is here assumed that these limitations are unbiased with respect to any given high school pattern. Practical consideration forced attrition to be defined in terms other than failure to graduate. For purposes of this study, students were classified into survival and attrition groups according to whether they were enrolled at the Iowa State College during the fall quarter of their sophomore year. The attrition and survival for each of the high school patterns are shown in Table 25.
Of the 997 entering freshmen in the Division of Agriculture, 606 or 60.8% were attending the Iowa State College one year later. The greatest attrition occurred among those students who followed a more general high school pattern and the smallest among those who followed a mathematics-science pattern. A test of significance was made by computing chi square when expected frequencies for the eight-cell tables were obtained from row and column totals. Chi square was found to be 14.94 which is highly significant.

Before drawing conclusions concerning the effectiveness of high school patterns, it was deemed important to test the necessity of stratification on the basis of farm and nonfarm residence and the necessity of controlling on student ability by the use of American
Council on Education Psychological Examination scores and freshman marks in English, both assumed to be independent of the high school pattern.

The necessity of stratification on the basis of residence was tested by means of chi square for each of the high school patterns. Thus, a four-cell table for each pattern was made with farm and nonfarm as the table headings and survival and attrition as the stub items.

The values of chi square obtained were

- Mathematics-science pattern = 0.4297
- Vocational agriculture pattern = 0.0929
- Other vocational pattern = 1.0777
- General pattern = 0.4355

None of the foregoing values was significant. Since the hypothesis could not be rejected that the attrition tendency prevails equally among farm and nonfarm students, no justification was available for stratification on the basis of residence.

It is well known that attrition is related to student aptitude. Since student aptitude has been shown previously to differ among the high school patterns, some method of control had to be devised.

The method chosen was an extension of the discriminant function technique developed by Fisher\(^1\). It was originally developed for

the purpose of ascertaining the most appropriate weights for a series of variables yielding maximum separation into two groups and noting the significance of such separation from random selection. An example of this use of the discriminant function is an education problem has been reported by Johnson.¹

Recently an exploratory attempt was made to use the discriminant function for (a) obtaining multiple biserial R and (b) ascertaining the desirability of elimination or addition of variables to a battery for predicting attrition tendency.²

Herdman³ used this technique for predicting high school attrition from I. Q., age at entrance and elementary school grade average. He then tested whether a significant loss would occur by eliminating elementary school grade average.

MacRae⁴ followed a similar procedure for testing the significance of the Minnesota Personality Scale for predicting freshman attrition of engineering students when student aptitude was controlled.

⁴MacRae, John M. Usefulness of the Minnesota Personality Scale For Predicting Achievement of Freshman Engineering Students. Unpublished M. S. Thesis. Iowa State College. 1949.
In all of the foregoing a discriminant function is obtained by solving simultaneously the following equations:

\[
\begin{align*}
    d_1 &= a_1 x_1^2 + b_1 x_1 x_2 + c_1 x_1 x_3 + \ldots \\
    d_2 &= a_2 x_2 + b_2 x_2^2 + c_2 x_2 x_3 + \ldots \\
    d_3 &= a_3 x_3 + b_3 x_3 x_2 + c_3 x_3^2 + \ldots
\end{align*}
\]

Each \(d\) in the foregoing is the difference between the means of the two groups on a given characteristic. The sum of squares and products are "within deviation" values obtained in the characteristic manner as in covariance problems.

In fact, the right-hand members of the foregoing equations are identical with those used for obtaining the "within" regression equation in covariance analysis. The left-hand members are replaced by \(\sum x_i y\), \(\sum x_i^2\), \(\sum x_i y\), etc.

In an attrition problem, if zero is assigned to each member of the attrition group and unity is assigned to each member of the survival group and the "within" regression solved, it yields the discriminant function. The left-hand members of the simultaneous equations are most easily obtained from

\[
\frac{k_A \sum x_S - k_S \sum x_A}{N}
\]
Solution of the equations will yield a difference of means of unity between the survival and attrition groups. Not only will the discriminant function result from this solution, but also it will result whenever the left-hand member is multiplied by any constant. Any such constant inserted would indicate the postulated difference in the means of the survival and attrition groups.

It will be here assumed that survival-attrition tendency is a characteristic that is normally distributed which is exhibited only in the dichotomy of survival and attrition. Furthermore, any relationship is linear which exists between survival-attrition tendency and freshman English marks or scores on the American Council on Education Psychological Examination.

It is further assumed that the difference between the means of the survival and attrition groups should be expressed in terms of standard deviation units obtained from the medians of the groups. Normal curve tables readily indicate the desired sigma unit differences.

The left-hand member for any characteristic then may be found from

\[ V = M \frac{k_A X_S - k_S X_A}{N} \]

Where "M" is the sigma difference between the medians of the survival and attrition group which in this study is 1.3688. The equations for solution are
\[
V_1 = a_1 \Sigma x_1^2 + b_1 \Sigma x_1 x_2 \\
V_2 = a_2 \Sigma x_1 x_2 + b_2 \Sigma x_2 
\]

Where all are deviation scores within the four high school patterns.

The needed values for solution are shown in Table 26.

Substituting into the foregoing equations

\[
(1.3688)(2028.2143) = 524663.11a + 7502.1566b \\
(1.3688)(134.96196) = 7502.1566a + 928.22515b 
\]

Solving for values of \( a \) and \( b \) the regression is obtained in deviation form

\[
\frac{\bar{X}}{\sigma} = 0.002765208x_1 + 0.1766714x_2 
\]

If prediction is desired from raw scores of \( X_1 \) and \( X_2 \), the needed constant may be obtained from \( C = \bar{Y} - a \bar{X}_1 - b \bar{X}_2 \)

where mean of \( \bar{Y} \) is the sigma distance of the point dividing the survival and attrition groups which from a normal curve table is 0.27364 for 606 and 391 in the survival and attrition groups, respectively. The equation for predicting survival-attrition tendency for any individual or for a group is

\[
\frac{\bar{X}}{\sigma} = 0.002765208x_1 + 0.1766714x_2 - 0.29439429 
\]

Such predicted \( \frac{\bar{X}}{\sigma} \)'s may be converted into probabilities from tables of the normal curve. Thus the probability of survival for a
Table 26
Information Needed for Solving the Discriminant Function

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>185</td>
<td>116</td>
<td>88</td>
<td>217</td>
<td>606</td>
<td></td>
</tr>
<tr>
<td>Survival</td>
<td>$\Sigma x_1$</td>
<td>20749</td>
<td>11763</td>
<td>9048</td>
<td>21810</td>
<td>63370</td>
</tr>
<tr>
<td></td>
<td>$\Sigma x_2$</td>
<td>373</td>
<td>200</td>
<td>167</td>
<td>395</td>
<td>1135</td>
</tr>
<tr>
<td>N</td>
<td>79</td>
<td>72</td>
<td>69</td>
<td>171</td>
<td>391</td>
<td></td>
</tr>
<tr>
<td>Attrition</td>
<td>$\Sigma x_1$</td>
<td>8123</td>
<td>6976</td>
<td>6329</td>
<td>15610</td>
<td>37038</td>
</tr>
<tr>
<td></td>
<td>$\Sigma x_2$</td>
<td>114</td>
<td>94</td>
<td>77</td>
<td>214</td>
<td>499</td>
</tr>
<tr>
<td>N</td>
<td>264</td>
<td>188</td>
<td>157</td>
<td>388</td>
<td>997</td>
<td></td>
</tr>
<tr>
<td>Both</td>
<td>$\Sigma x_1$</td>
<td>28872</td>
<td>18739</td>
<td>15377</td>
<td>37420</td>
<td>100408</td>
</tr>
<tr>
<td></td>
<td>$\Sigma x_2$</td>
<td>487</td>
<td>294</td>
<td>244</td>
<td>609</td>
<td>1634</td>
</tr>
</tbody>
</table>

RAW SCORE  DEVIATION  WITHIN DEVIATION

$\Sigma x^2_1 = 10,683,622$  571,519.23  524,663.11

$\Sigma x^2_2 = 3702$  1024.01003  928.22515

$\Sigma x_1 x_2 = 173,916$  9,355.6469  7,502.1566
student who had a score of fifty on the American Council on Education Psychological Examination and who received a failure in freshman English can be found by substitution in the equation yielding

$$\frac{x}{\sigma} = -0.1561$$

By consulting a table of normal curve, the probability of survival for such a student is 0.438.

At the other extreme, a student with an American Council on Education Psychological Examination score of 150 and an English mark of A would yield a predicted sigma score of 0.8271 or a survival probability of 0.796. Variation in predicted scores is a function of the degree to which the survival-attrition tendency can be predicted from the available data. Such relationship may be had by computing a multiple biserial R from the formula

$$R_{bis} = \frac{d - pq}{\sigma z}$$

Where

- $d$ = difference in the predicted means of the survival and attrition groups
- $\sigma$ = standard deviation of entire group
- $p$ and $q$ = proportions in the two groups
- $z$ = height of ordinate separating two groups

The $d$ and $\sigma$ may be found without making prediction for each
of the 997 students. The former may be found from

\[ d = 0.0027652080d_1 + 0.17667147d_2 \]

Where \( d_1 \) and \( d_2 \) are differences between means of survival and attrition groups on the two control variables. Thus \( d = \)

\[ 0.002765208 \left[ \frac{62370}{606} - \frac{37038}{391} \right] + 0.17667147 \left[ \frac{1135}{606} - \frac{499}{391} \right] \]

\[ d = 0.13264624 \]

The standard deviation of predicted scores may be found from

\[ \sigma = \sqrt{\frac{\Sigma [0.002765208x_1 + 0.17667147x_2]^2}{997}} \]

or

\[ \sigma = \sqrt{\frac{0.0000076463753\overline{x}^2_1 + 0.00097706672\overline{x}x_12 + 0.031212808\overline{x}^2_2}{997}} \]

Substituting \( \overline{x}^2 \), \( \overline{x}x_1 \), and \( \overline{x}^2_2 \), deviation values for total rather than within high school pattern

\[ \sigma = 0.21356544 \]

Substituting in the formula for multiple biserial \( R \)

\[ R_{bis} = \frac{0.13264624}{0.21356544} \left[ \frac{(0.60782347)(0.39217653)}{.3842} \right] \]

\[ R_{bis} = 0.3854 \]
The effectiveness of the controls was less satisfactory for survival-attrition tendency than for that previously found for first-quarter agricultural achievement.

The modified discriminant function can be utilized for making allowances for the differences in student aptitude as indicated by control factors among the students in the four high school patterns.

Two methods, quite similar but not mathematically identical, have been used for making adjustments. Expected numbers based upon the modified discriminant function can be found and chi square computed between expected and actual frequencies in the eight-cell table when classification is made on attrition-survival and high school pattern. Another method would be to adjust the actual survival and attrition frequencies to the same mean control factors in each group as prevail in the group as a whole. These new frequencies can be tested by chi square against expected numbers obtained from row and column totals in the usual manner. Both methods have been followed in this study.

To determine expected numbers, sigma scores were predicted for each group from

$$\bar{x} = 0.0027652080 \bar{X}_1 + 0.17667147 \bar{X}_2 - 0.29439429$$
Expected sigma scores are shown in Table 27. These have been converted into a survival probability which in turn has yielded an expected survival frequency when multiplied by the total number in each high school pattern.

Table 27

Predicted Expected Survival Frequencies

<table>
<thead>
<tr>
<th>Pattern</th>
<th>$\bar{X}$</th>
<th>$\sigma$</th>
<th>$F$</th>
<th>$N$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics-science</td>
<td>0.33392</td>
<td>0.6308</td>
<td>166.53</td>
<td></td>
</tr>
<tr>
<td>Vocational agriculture</td>
<td>0.25751</td>
<td>0.6018</td>
<td>113.14</td>
<td></td>
</tr>
<tr>
<td>Other vocational</td>
<td>0.25101</td>
<td>0.5991</td>
<td>94.06</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>0.24959</td>
<td>0.5985</td>
<td>232.22</td>
<td></td>
</tr>
</tbody>
</table>

Chi square was computed for survival-attrition among the high school patterns with the expected frequencies predicted from the modified discriminant function. The data for the analysis are shown in Table 28.

When chi square was computed a value of 9.1885 was found which is significant at the 5% level. Since the discrepancy was significant, a further analysis was made by contrasting the mathematics-science pattern with all others. Chi square was found to be 7.4763 which for one degree of freedom is highly significant.
Table 28

Actual and Predicted Expected Frequencies

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Survival</th>
<th>Attrition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual</td>
<td>Expected</td>
</tr>
<tr>
<td>Mathematics-science</td>
<td>185</td>
<td>166.53</td>
</tr>
<tr>
<td>Vocational agriculture</td>
<td>116</td>
<td>113.14</td>
</tr>
<tr>
<td>Other vocational</td>
<td>88</td>
<td>94.06</td>
</tr>
<tr>
<td>General</td>
<td>217</td>
<td>232.22</td>
</tr>
</tbody>
</table>

Next an analysis was made of three high school patterns with the mathematics-science pattern omitted. The expected numbers shown in Table 28 were adjusted proportionally to make the sum of the expected numbers equal to the sum of the actual frequencies. Chi square was found to be 1.6923, a nonsignificant value.

Under the assumption that expected numbers can be obtained by the use of the modified discriminant function three conclusions seemed warranted. First, the four patterns are not equally effective when evaluated in terms of survival-attrition. Second, the mathematics-science pattern is superior to others. Third, when the mathematics-science pattern was eliminated and chi square was computed for the remaining three patterns, the idea that all three were equally effective could not be rejected.
In the foregoing analyses, actual frequencies have been used directly while the expected frequencies have been adjusted for student aptitude as measured by marks in college English and scores on the American Council on Education Psychological Examination.

Table 29

Adjusted Actual Survival Frequencies

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Survival</td>
<td>185</td>
<td>116</td>
<td>88</td>
<td>217</td>
</tr>
<tr>
<td>Proportion Survival</td>
<td>.70075</td>
<td>.61702</td>
<td>.56051</td>
<td>.55928</td>
</tr>
<tr>
<td>( \hat{x} )</td>
<td>.52656</td>
<td>.29761</td>
<td>.15223</td>
<td>.14914</td>
</tr>
<tr>
<td>Adjustment</td>
<td>.06028</td>
<td>-.01613</td>
<td>-.02263</td>
<td>-.02405</td>
</tr>
<tr>
<td>Adjusted ( \hat{x} )</td>
<td>.46628</td>
<td>.31374</td>
<td>.17486</td>
<td>.17319</td>
</tr>
<tr>
<td>Adjusted Proportion</td>
<td>.67950</td>
<td>.62314</td>
<td>.56941</td>
<td>.56875</td>
</tr>
<tr>
<td>Adjusted Actual</td>
<td>179.39</td>
<td>117.15</td>
<td>89.40</td>
<td>220.68</td>
</tr>
</tbody>
</table>

An alternate approach was also made by adjusting the actual frequencies for student aptitude and using expected numbers obtained from row and column totals in the usual manner.

The steps in the procedure are shown in Table 29. The actual number of survivors was divided by the total number in each pattern
to determine survival proportion. These proportions were changed to sigma units. The modified discriminant function was solved for each pattern. The $x_1$ and $x_2$ used in the equation were the means of the characteristic in any given pattern minus the means of the characteristic in all patterns combined.

The mean differences were:

<table>
<thead>
<tr>
<th>Pattern</th>
<th>$\text{AGE (}x_1\text{)}$</th>
<th>$\text{English Mark (}x_2\text{)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math.-Science</td>
<td>8.6535061</td>
<td>0.2057801</td>
</tr>
<tr>
<td>Voc. Ag.</td>
<td>-1.0345984</td>
<td>-0.07508697</td>
</tr>
<tr>
<td>Other Voc.</td>
<td>-2.7674551</td>
<td>-0.08477666</td>
</tr>
<tr>
<td>General</td>
<td>-4.2668310</td>
<td>-0.06932916</td>
</tr>
</tbody>
</table>

Solutions to the four equations produced adjustments which were subtracted from the sigma scores. The adjusted sigma scores were converted to proportions and then into adjusted survival frequencies.

Chi square was then computed between adjusted frequencies and expected frequencies, obtained from row and column totals. The needed information is shown in Table 20. Chi square was 9.336 which is significant at the 5% level. This chi square value differs but little from 9.1885 which was found when actual frequencies and adjusted expected numbers were used as shown in Table 28.
The mathematics-science pattern apparently is more effective when evaluated in terms of attrition. If the mathematics-science pattern should be eliminated from Table 30, the chi square for the three remaining patterns is 3.740 which is not significant.

Table 30

Adjusted Actual and Expected Frequencies of Survival-Attrition

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Survival</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adjusted</td>
<td>Expected</td>
<td>Adjusted</td>
</tr>
<tr>
<td>Mathematics-science</td>
<td>179.39</td>
<td>160.63</td>
<td>84.61</td>
</tr>
<tr>
<td>Voc. Agriculture</td>
<td>117.15</td>
<td>114.39</td>
<td>70.85</td>
</tr>
<tr>
<td>Other vocational</td>
<td>89.40</td>
<td>95.53</td>
<td>67.60</td>
</tr>
<tr>
<td>General</td>
<td>220.68</td>
<td>236.08</td>
<td>167.32</td>
</tr>
</tbody>
</table>

From the evidence at hand, the inference seems warranted that the mathematics-science pattern is more effective than other patterns in terms of first year survival-attrition in the Division of Agriculture at the Iowa State College.
VII. SUMMARY

The greatly increased enrollment during the past few years has brought students with a great variety of high school backgrounds into college. It was the purpose of this study to evaluate the various types of high school background submitted by the students for entrance into the Iowa State College Division of Agriculture. The evaluation was made in terms of the college achievement of the students with the various high school backgrounds. The criteria of achievement were (1) honor point ratio earned in first-quarter agriculture courses; (2) mark received in the initial course in chemistry; and (3) attrition-survival beyond the freshman year. No attempt has been made to define college achievement in terms of intangible benefits to the students such as personal satisfaction. Neither was there any attempt made to evaluate the various types of high school programs in terms of objectives of secondary education.

There were 997 male freshman students who entered the Iowa State College Division of Agriculture during the fall quarters of 1946, 1947 and 1948 for whom complete data were available.

Transfer students, female students and students for whom records were incomplete were eliminated from the study. The 997 students
were classified into four high school pattern groups. All students who had taken three or more units of high school agriculture were designated as vocational agriculture high school students. All students who had taken six or more units of any combination of high school mathematics and science were designated as mathematics-science students. All students who had taken six or more units of high school vocational subjects other than agriculture were designated as other vocational students. All students with other combinations of high school background were designated as general pattern students. Because achievement in agriculture might be related to farm experience each of the foregoing groups was stratified into farm and nonfarm subgroups. The basis of the latter stratification being the father's occupation which the student reported.

To control upon scholastic ability, scores made on the American Council on Education Psychological Examination and first marks earned in the initial English course were used.

A. Agriculture Achievement

Analysis of variance single classification, analysis of variance multiple classification with correction for disproportion among subgroups and analysis of covariance single classification
with American Council on Education Psychological Examination scores and English marks controlled were used to compare the agriculture achievement of the various groups and subgroups. No significant differences could be found in the achievement of the students in the various years. Students with farm backgrounds made significantly greater agriculture achievement than did students with nonfarm backgrounds. Significant differences in agriculture achievement were found among the high school pattern groups. When each high school pattern was compared with all others the vocational agriculture group was found to have made greater agriculture achievement and the general pattern group was found to have made smaller agriculture achievement than had all other groups combined. The agriculture achievement of the mathematics-science group and the other vocational group did not significantly differ from that of all other groups combined.

Within each high school pattern group the students with farm backgrounds were found to have made significantly greater agriculture achievement than had the nonfarm students with the exception of the vocational agriculture pattern group. Within the vocational agriculture pattern group no significant difference in agriculture achievement could be found, between the farm and nonfarm background subgroups. To the degree that the various high school patterns can be
evaluated in terms of first-quarter agriculture course achievement, the vocational agriculture pattern gave the best preparation and the general pattern gave the poorest preparation for college.

B. Chemistry Achievement

Because the first course in chemistry could be taken at any time during the freshman or sophomore years the students who had entered college in the fall of 1948 had not all taken the first course in chemistry. Therefore, the 1948 group were excluded from the study of chemistry achievement. There was a total of 286 students who entered the Iowa State College Division of Agriculture during the fall quarters of 1946 and 1947 and had taken an initial chemistry course by the fall of 1949.

The first quarter of chemistry was reported as either 100A or 101. Chemistry 100A was the first course of a two-course sequence which dealt with the same subject matter as was presented in Chemistry 101. The marks reported were weighted for evaluation of achievement in an arbitrary 3 to 2 ratio as a compromise between considering quality of achievement and quantity of material covered by the students in the two courses.

The weighted chemistry marks of the previously described groups and subgroups were compared by techniques similar to those employed in the evaluation of agriculture achievement. It was found that no
significant differences in chemistry achievement could be demonstrated between the farm and nonfarm background groups. The farm and nonfarm groups were combined for subsequent analyses. When the chemistry achievement of the various high school groups were compared, significant differences were found. The chemistry achievement of the vocational agriculture, the other vocational and the general high school pattern groups was compared. No significant differences could be found. The previously noted differences in chemistry achievement were concluded to be associated with the mathematics-science group. A comparison of the mean weighted achievement of the various high school pattern groups corrected for differences in American Council on Education Psychological Examination scores and English marks revealed that the mathematics-science group made significantly greater chemistry achievement than did the other pattern groups.

To the extent that the various high school patterns can be evaluated in terms of weighted chemistry achievement, the mathematics-science pattern gave the best preparation for success. The other patterns did not differ from each other in the quality of preparation for achievement in initial college chemistry which they provided.
C. Attrition and High School Pattern

Of the 997 students included in this study, 606 were enrolled in the Iowa State College for the fall term following that in which they had entered as freshmen. The 391 students who failed to return were designated as the attrition group.

The differences among the various high school pattern groups in the proportions of students dropping out were made without control by chi square analysis in which expected numbers were derived from row and column totals. Using American Council on Education Psychological Examination scores and English marks as control factors, a modified discriminant function technique was used to derive expected numbers for a further chi square analysis. There were significant differences found among the high school pattern groups both with and without control. When an analysis was made on the attrition ratio among the vocational agriculture, other vocational and general pattern groups with the exclusion of the mathematics-science pattern group no significant differences could be found.

In so far as the various high school pattern groups can be evaluated in terms of their attrition ratios, the mathematics-science group is apparently the most effective. The other three pattern groups appear to be equally effective.
VIII. LITERATURE CITED


Harris, Daniel. The Relation of College Grades to Some Factors Other Than Intelligence. Archives of Psychology. 131. July 1931.


