AGE AND COLLEGE ACHIEVEMENT OF PUBLIC LAW 346 VETERANS AT IOWA STATE UNIVERSITY

by

Harlan Walworth Boyce

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INTRODUCTION

The Serviceman's Readjustment Act of 1944 (17), also known as the GI Bill of Rights, was passed by the 78th Congress and signed by the President on June 22, 1944. It was designed to give Federal assistance to World War II veterans in their transition from military to civilian life.

Those eligible for aid under this act, also called Public Law 346, were nondisabled World War II veterans who had served 90 days or more of active duty and were discharged under conditions other than dishonorable. Veterans who fulfilled those conditions were given an opportunity to train for one year in addition to a period not to exceed the time spent in active service. A maximum of four years training was possible. During the tenure of this bill, a total of 31,127 (19) men and women veterans were enrolled in colleges and universities in the state of Iowa.

When those eligible men and women began enrolling in colleges and universities, some apprehension was felt concerning the standards of the institutions. Consequently, many investigations were made which compared academic achievement of veterans with nonveterans, but the number of studies which were statistically analyzed was limited. Since the findings of those studies varied considerably and since still fewer attempts had been made to analyze the effect of age on achievement, there appeared to be a need for more statistical analysis of the relationship between age and achievement.

The sample for this investigation is identical with the group of 350

Public Law 346 veterans used by Hanson (9) in his evaluation of the veterans rehabilitation program for students entering Iowa State. It was at the suggestion of Hanson that this research was undertaken.

The results of this investigation should be of value as a supplement to Hanson's study and also useful to those who teach, counsel, and administer educational programs related to veterans or other adults.

REVIEW OF LITERATURE

Accurately predicting scholastic achievement has been a substantial problem for educational counselors, administrators, and persons interested in extending their formal education. Consequently, many investigations have been made in this area, but studies relating age to achievement are less numerous.

In 1933 at the University of Illinois, Odell (12) found, as shown in Table 1, that those who entered college or university at 17 or 18 had a slight advantage over those whose entrance ages were less or greater.

Table 1. Average high school and college marks and differences of college students grouped by age at entrance

Age at entrance	High school mark	College mark	Differences
16	87.6	85.4	-2.2
17	86.2	84.8	-1.4
18	85.0	83.5	-1.5
19	82.9	80.8	-2.1
20	82.1	78.7	-3.4
21	81.5	83.5	+2.0

However, he also felt justified in his conclusion that age was not a significant factor in the relationship between high school marks and college marks.

Hammans (8), in a recent study of 350 nonveterans who had entered Iowa State as freshmen, had graduated, had dropped, or had transferred to another school during the interval between winter quarter 1944 and the end of spring quarter 1953, found no evidence from his sample to

support a relationship between age and achievement. To arrive at his conclusion, Hammans used a quadratic regression equation of the form $Y = a_1X^2 + a_2X + a_3$. When analysis of quadratic regression had been completed, an F-value of 0.85 was not significant at the five per cent level nor did a coefficient of correlation of 0.0699 indicate a usable relationship between age and achievement.

Yung-Szi Liu (11b) studied 1077 native born Chinese graduate students who had been enrolled at the University of Michigan from 1907 to 1950. She found 70 per cent at matriculation were 25 years old or older and the ages of 110 cases were between 31 and 33. Furthermore, she found evidence that women slightly excelled men, that a small relationship existed between parents' occupations and academic success, and that evidence of a strong relationship existed between achievement and the educational institutions which had awarded the baccalaureate degrees. Age at matriculation and geographical location of pre-college residence had no significant relationship to college achievement.

At the University of Oklahoma, Lehr (11a) conducted an investigation of attrition of persons who had been enrolled in Northwestern State College, Alva, Oklahoma. His sample was selected from students who had matriculated for the fall semester of the years 1950 through 1954 and had completed one full semester with a class load of at least 12 hours. Five hundred seventeen were able to meet those standards, and 343 of them attended at least three semesters to be classified as "non-drop-outs." Of the 517 selected, 174 failed to attend three semesters and were considered "drop-outs." The relationship of each of 12 factors, including

age, sex, and service status to the "drop-out" and "non-drop-out" groups was then statistically analyzed. No differentiation was made concerning "sex" or "service status" during the investigation except when each was examined as a factor related to student attrition.

When the analysis of variance was completed to test the relation of age to attrition, an F-value of 0.272 was found to be far short of significance at the one per cent level. However, when a table was constructed which contrasted veteran drop-out tendency with nonveteran drop-out tendency; veterans, in general, were found to remain in school longer than nonveterans.

The results of a survey by Kamm and Wrenn (10) tended to confirm the conclusions of numerous investigations which had compared academic success of veterans with nonveterans and had found veterans' averages excelled those of nonveterans. In their survey, Kamm and Wrenn received a 78.7 per cent response from the 155 coeducational liberal arts colleges and universities in the 19 states of the North Central Association of Colleges and Secondary Schools. Partial results of the survey as found by Kamm and Wrenn were:

> . . . 2/3 of all reporting institutions stated that the scholastic achievement of veterans is superior to that of nonveterans. None of the schools said that the veterans are inferior scholastically, and one-third indicated that there is no difference between the two groups.

Results of a different nature were found by Owens and Owens, Jr. (15) when they investigated the relationship of age, length of service, and scholastic aptitude to college achievement of a sample of 194 male veterans enrolled in the Winona State Teachers College, Winona, Minnesota.

The mean age of the sample was 23 years three months. By using the statistical method of multiple correlation, age was found to be nearly as good a predictor of academic achievement as was the college aptitude test score. A low negative relationship existed between length of service and grade point average, and the correlation between aptitude test score and grade point average was increased from 0.47 to 0.57 by including estimates of the contributions of age and length of service to this relationship.

A statistical analysis of the relationship of age at matriculation to achievement was conducted at Iowa State by Bengtson (2) with a sample of 350 male disabled veterans. Bengtson also stipulated that cases in his sample had graduated from secondary schools within the United States and had entered Iowa State without previous college experience. Furthermore, they had matriculated, graduated, dropped, or transferred to another institution during the time interval between the beginning of winter quarter 1944 and the end of spring quarter 1953.

To investigate the relationship of age to achievement, a quadratic regression equation of the form $Y = a_1X^2 + a_2X + a_3$ was analyzed to determine the index of correlation. An R of 0.0616 was too low to indicate evidence of a significant relationship between age and achievement. When the sample was divided into four-year age groups, as shown in Table 2, and the mean for each group computed, differences between means were found, but t-tests failed to yield a single relationship between means significant at the five per cent level.

In the course of this investigation, studies were reviewed concern-

ing the relationship of age at matriculation to academic success of veterans and nonveterans. Also reviewed were comparisons of the achievement of veterans to nonveterans, and studies concerning factors related to the academic success of veterans.

Table 2. Mean grade point averages and number of cases in age groups of disabled veterans

Age	Number of cases	Mean grade point average
30-up	20	2.317
26-29	45	2.022
22-25	141	2.120
18-21	144	2.064

Of the studies reviewed, three used the total grade point average of the college career, four differentiated between disabled and nondisabled veterans, one tested the relationship of age at matriculation to achievement of disabled veterans, but none had statistically analyzed the value of age as a predictor of academic achievement for Public Law 346 veterans.

METHOD OF PROCEDURE

Purpose

The purpose of this investigation was to determine the relationship between age and scholastic achievement of Public Law 346 veterans who attended Iowa State University of Science and Technology.

Hypothesis and Basic Assumptions

To facilitate statistical analysis, a null hypothesis was adopted, i.e., there is no relationship between college entrance age and achievement of veterans who attended Iowa State under the provisions of Public Law 346.

The assumption was made that the cumulative grade point average of all marks recorded at the time of graduation, dropping, or transferring from Iowa State would be a satisfactory measure of scholastic achievement.

Criterion of Age

For purposes of this study, age was defined as the age to the nearest year at the time of matriculation.

Criterion of Achievement

For the measure of academic achievement, this study used a cumulative grade point average composed of all marks recorded at the time of graduation, dropping out of school, or transferring to another college or university. This criterion was used because there may have been large

variations among instructors in evaluating achievement. It was felt that by using a cumulative grade point average composed of all recorded marks, objections to variations in grading would be reduced.

The grade point average for this study was determined by assigning numerical values to the letter marking system used at Iowa State. The values 4, 3, 2, 1 and 0 were assigned respectively to the letter marks A, B, C, D, and F.

Selection of Sample

This study used a sample of 350 male Public Law 346 veterans who had enrolled at Iowa State during or after winter quarter 1944 and had graduated, dropped, or transferred to another school by the end of spring quarter 1953. Other delimitations of the sample were; the cases should have had no college experience before enrolling at Iowa State; should have graduated from secondary schools within the United States; and should have registered as freshmen in a full-length curriculum, not a short-term course.

By the end of spring quarter 1953, approximately 12,500 veterans had enrolled at Iowa State. The registrar's records were examined and, in alphabetical order, every tenth Public Law 346 case was selected for study. Of 1156 cases selected, only 522 satisfied the criteria of this investigation. Of the 522 cases, 61 per cent graduated, 16 per cent transferred to another school and 23 per cent dropped for personal or academic reasons.

The ratio of graduates, transfers, and drops (Table 3) was held

Table 3. Ratio of graduates, transfers, and drops of Public Law 346 veterans at Iowa State

	Number sampled	Number included
Received B.S. Degree	318	214
Transferred	84	56
Dropped	120	80
Total	522	350

constant when the technique of random numbers was employed to select the final sample.

The distribution of college entrance ages of Public Law 346 veterans who graduated, dropped, or transferred from Iowa State is illustrated in Table 4.

Statistical Treatment

Statistical techniques used in treatment of the data were analysis of variance-single classification, analysis of variance and linear regression, analysis of quadratic regression, and advantage of quadratic over linear regression. The method of procedure for these techniques has been related by Wert et al. (20).

The analysis of variance was computed to provide a test of the significance of the differences of achievement among the different age groups simultaneously.

Table 4. Distribution of college entrance ages of Public Law 346 veterans who graduated, dropped, or transferred from Iowa State

Age*	Graduates	Transfers	Drop	Total
17	2	0	1	3
18	10	1	2	13
19	24	11	4	39
20	41	6	23	70
21	46	10	14	70
22	28	8	8	44
23	17	7	10	34
24	13	2	7	22
25	11	2	5	18
26	4	4	2	10
27	6	2	1	9
28	4	0	1	5
29	6	2	1	9
30-48	2	1	1	4
Total	214	56	80	350

*Range 17 yrs. 1 mo. to 48 yrs. 1 mo.
Median age 21 yrs. 8 mo.

The linear regression equation was then solved, and information from it was used in the analysis of variance and linear regression to test for linearity or nonlinearity of the regression line. Since the possibility of a nonlinear relationship between age and achievement was indicated, analysis of quadratic regression was completed to test the index of correlation between age and achievement and to test the significance of the regression equation for predicting academic achievement from age.

The concluding step in the statistical analysis was to test the

advantage of quadratic regression over linear regression for predicting the criterion from the prediction variable of this sample.

AGE AND ACHIEVEMENT

In making this investigation of the relationship between age and achievement, the prediction variable was defined as age to the nearest year at the time of entering college.

The criterion of achievement was defined as grade point average, which is the cumulative average of all grade points earned at Iowa State. Letter marks of A, B, C, D, and F were assigned numerical values of 4, 3, 2, 1, and 0, respectively. In computing the grade point average, each course mark was weighted by the number of hours of credit which the course carried. Thus, for any given student the grade point average could vary from 4.00 to 0.00.

The analysis of variance, single classification with unequal frequency in groups, was first used to provide a test of the significance of the differences among age groups simultaneously. Inspection of Table 5 reveals differences among the age groups. To test the significance of differences among age groups, the null hypothesis was assumed. In other words, a homogenous population was postulated from which variation among samples as great as that shown could reasonably be attributed to sampling fluctuation. A test for determining whether the null hypothesis was tenable was then made.

To accomplish the testing of the hypothesis, the entries in Table 6 were completed.

The following equations were used for computing sum of squares. For total:

$$S.S._t = \Sigma Y^2 - \frac{(\Sigma Y)^2}{N}$$

Table 5. Cumulative grade point average of Public Law 346 veterans by age groups

Age	n	ΣY	$\frac{(\Sigma Y)}{n}$
17	3	6.272	2.090666
18	13	34.155	2.627308
19	39	94.837	2.431717
20	70	146.908	2.098686
21	70	164.212	2.345886
22	44	89.096	2.024909
23	34	72.177	2.122853
24	22	48.375	2.198864
25	18	37.329	2.073833
26	10	21.621	2.162100
27	9	23.704	2.633778
28	5	10.831	2.166200
29	9	21.917	2.435222
30-up	4	8.884	2.221000
Total	350	780.318	
Grand mean		2.2294	

Table 6. Analysis of variance of achievement among age groups of Public Law 346 veterans

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F
Age groups	13	10.458803	.804523	1.921
Within	336	140.708681	.418775	
Total	349	151.167484	.43314	

For groups: $$S.S._g = \frac{(\Sigma Y_1)^2}{n_1} + \frac{(\Sigma Y_2)^2}{n_2} + \cdots + \frac{(\Sigma Y_k)^2}{n_k} - \frac{(\Sigma Y)^2}{N}$$

For within: $$S.S._w = S.S._t - S.S._g$$

Substituting the necessary values, which may be found in the Appendix, the equations became

$$S.S._t = 1890.870858 - \frac{(780.318)^2}{350} = 151.167484$$

$$S.S._g = 1750.162177 - \frac{(780.318)^2}{350} = 10.458803$$

$$S.S._w = 151.167484 - 10.458803 = 140.708681$$

The mean square values needed in Table 6 were obtained by dividing the sum of squares by the corresponding degrees of freedom.

To test the significance of the differences among the 14 age levels, these estimates of variance were compared by

$$F = \frac{\text{age groups mean square}}{\text{within mean square}}$$

In Table 6 then,

$$F_{13,336} = \frac{0.804523}{0.418775} = 1.921$$

When a table of F was consulted, a value of 1.921 with 13 and 336 degrees of freedom was found to be significant beyond the five per cent level but not the one per cent level, and the null hypothesis was rejected. Evidence was found to indicate that the variation in grade point averages of the age groups was greater than could be attributed to an error in sampling.

Since a relationship between age, the prediction variable, and achievement, the criterion, appeared to exist, predicting values in one distribution from known values in the other distribution should have been possible.

If the data representing the criterion and the prediction variable were plotted, the line assumed to be satisfactory for predicting the criterion from the prediction variable, called a regression line, might or might not be linear.

Present knowledge of the learning process, as indicated by some authorities, would tend to indicate a nonlinear relationship. One method of obtaining mathematical support for the suspicion of nonlinearity consists of comparing the sum of squares for linear regression with the sum of squares for grouped data.

An equation representing a linear relationship is

$$Y = aX + C$$

The values of a and C are so chosen that the sum of squares of residuals is a minimum, i.e.,

$$\Sigma(Y - aX - C)^2 = \text{a minimum.}$$

By differentiating with respect to a and C respectively and setting the first derivative equal to 0, making the multiplications and dividing by -2 in each of the equations, the following normal equations are produced:

$$\Sigma XY = a\Sigma X^2 + C\Sigma X$$

$$\Sigma Y = a\Sigma X - CN$$

Substituting the necessary values, which may be found in the Appendix, the equations become

$$17107.142 = a\ 172134.0 + 7682\ C$$

$$780.318 = a\ 7682.0 + 350\ C$$

Upon solution of these simultaneous equations the linear regression equation was found to be

$$Y = -\ 0.00559521176\ X + 2.352286904$$

Using information from Table 6 and this equation, Table 7 was set up.

Table 7. Analysis of variance and linear regression

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F
Age groups	13	10.458803	0.804523	
Linear regression	1	0.110356	0.110356	
Difference	12	10.348447	0.862371	2.06
Within	336	140.708681	0.418775	
Total	349	151.167484		

An F value of 2.06 with 12 and 336 degrees of freedom, significant at the five per cent level, supports the suspicion of nonlinearity. Therefore, a nonlinear regression equation will be tested to determine its value in predicting achievement from age.

From the information in Tables 6 and 7 the regression line was determined to be nonlinear.

One nonlinear regression is a quadratic equation of the form

$$Y = a_1X^2 + a_2X + C$$

where values for the constants a_1, a_2 and C are so selected that the sum of squares of the residuals is a minimum, i.e.,

$$\Sigma(Y - a_1X^2 - a_2X - C)^2 = \text{a minimum.}$$

By partially differentiating this expression with respect to a_1, a_2, and C and setting the first derivative in each case equal to 0, the normal equations are

$$\Sigma X^2Y = a_1 \Sigma X^4 + a_2 \Sigma X^3 + C \Sigma X^2$$

$$\Sigma XY = a_1 \Sigma X^3 + a_2 \Sigma X^2 + C \Sigma X$$

$$\Sigma Y = a_1 \Sigma X^2 - a_2 \Sigma X + N C.$$

After substituting the necessary values, which may be found in the Appendix, the normal equations become

$$383167.092 = 94743846.0a_1 + 3963398.0a_2 + 172134.0C$$

$$17107.142 = 3963398.0a_1 + 172134.0a_2 + 7682.0C$$

$$780.318 = 172134.0a_1 + 7682.0a_2 + 350.0C$$

When these equations were solved simultaneously for a_1, a_2, and C, the quadratic regression equation was found to be

$$Y = 0.001257565648\ X^2 - 0.07170163781\ X + 3.184743359.$$

The analysis of this quadratic regression equation is found in Table 8.

Table 8. Analysis of quadratic regression for predicting grade point average from age

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F
Quadratic regression	2	0.656867	0.3284335	0.757
Quadratic residuals	347	150.510617	0.433748175	
Total	349	151.167484	0.43314465	

$$R = \sqrt{\frac{0.656867}{151.167484}} \qquad R = 0.066$$

As shown in Table 8, the values of F and R are so low that to use the quadratic equation with this sample to predict academic achievement from age is not practical.

Table 9 was developed from information in Tables 7 and 8 to determine the advantage of the quadratic regression equation over linear regression. The 1.26 value of F with one and 347 degrees of freedom was not significant at the five per cent level. Although information from Table 9 corroborated Table 7 in evaluating the best regression line as nonlinear, this sample would indicate quadratic regression is only slightly more valuable than linear regression for predicting achievement from age.

From the analysis of variance, the null hypothesis was rejected since the F-test for differences of achievement among age groups was significant at the five per cent level, but because the value was low and

Table 9. Advantage of quadratic over linear regression for predicting grade point average from age

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F
Quadratic regression	2	0.656867	0.3284335	0.757
Linear regression	1	0.110356	0.110356	0.254
Advantage	1	0.546511	0.546511	1.26
Quadratic residuals	347	150.510617	0.433748	
Total	349	151.167484		

the variation was not systematic, the relationship has little practical value.

On the basis of this evidence, there was no indication that older veterans are less able to achieve than younger veterans.

SUMMARY

The purpose of this investigation was to determine the value of age in predicting achievement of Public Law 346 veterans at Iowa State University of Science and Technology. Age was defined as the age to the nearest year at the time of matriculation, while achievement was defined as the cumulative grade point average of all marks received at the time of graduation, dropping out of school, or transferring to another college or university.

A satisfactory standard of achievement was assumed to be cumulative grade point average of all marks received at the time of graduation, transferring, or dropping out for personal or academic reasons.

To facilitate statistical analysis, a null hypothesis was assumed, i.e., there is no relationship between college entrance age and achievement of Public Law 346 veterans who attended Iowa State.

In developing this evaluation of age and achievement, data was used which had been compiled by Hanson (9) concerning a group of veterans which had been enrolled at Iowa State under provisions of The Serviceman's Readjustment Act of 1944, or Public Law 346 as it was commonly called. From the registrar's files, Hanson chose every tenth Public Law 346 veteran, and further limited the group by retaining only those male veterans who had no college experience before enrolling in Iowa State; who had graduated from secondary schools within the United States; who had registered as freshmen in a full length curriculum, not a short course; and who had enrolled in Iowa State, graduated, dropped, or transferred during the period of time beginning with winter quarter, 1944, and

extending through spring quarter, 1953.

Of the 522 selected, 318 or 61 per cent were graduated, 84 or 16 per cent transferred, and 120 or 23 per cent dropped for personal or academic reasons. The ratio of graduates, transfers, and drops was held constant when the technique of random numbers was employed to select the 350 cases in the final sample. College entrance ages of Public Law 346 veterans ranged from 17 years one month to 48 years one month, with a median age of 21 years eight months.

Analysis of the differences of achievement among age groups yielded an F-value of 1.92 which was significant beyond the five per cent level. The null hypothesis was rejected because this evidence indicated variation in grade point average among age groups greater than could be attributed to sampling error.

To test the linearity or nonlinearity of the relationship, the mean sum of squares for linear regression was compared with the mean sum of squares for grouped data. The resulting F-value of 2.06, which was significant beyond the five per cent level, indicated a nonlinear equation would be more valuable than a linear equation for predicting achievement from age. However, the nonsignificant F-value of 0.757, found in the analysis of quadratic regression, indicated the quadratic regression equation was of little practical value.

When the advantage of quadratic regression over linear regression was analyzed, the nonsignificant F-value of 1.26 indicated the quadratic regression equation was of little more value than linear regression, which was valueless for practical purposes.

Since the F-test for differences of achievement among age groups was significant at the five per cent level, the null hypothesis was rejected, but because the level of significance was low and the variation was not systematic, the relationship has little practical value. On the basis of this evidence, there was no indication that older veterans are less able to achieve than younger veterans.

The results of this investigation, along with those of previous studies relative to age and achievement, should serve as valuable guides to counselors and guidance personnel. Further information might be available from a statistical analysis of records of veterans who have attended or are attending colleges and universities under provisions of Public Law 550 (18).

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APPENDIX

Basic Information for Public Law 346 Veterans

X = age

Y = cumulative grade point average

N = 350 cases

n = cases in any one age group

k = 14 age groups

ΣY = 780.318

ΣY^2 = 1890.870858

ΣX = 7682.00

ΣX^2 = 172134.00

ΣX^3 = 3963398.00

ΣX^4 = 94743846.00

ΣXY = 17107.142

$\Sigma X^2 Y$ = 383167.092

$\frac{(\Sigma Y)}{N}$ = 2.229

Table 10. Basic information for Public Law 346 veterans by age groups

Age	n	(ΣY)	(ΣY^2)	$\frac{(\Sigma Y)^2}{n}$	$\frac{\Sigma Y}{n}$
17	3	6.272	13.869378	13.112661	2.090
18	13	34.155	93.266125	89.73569	2.627
19	39	94.837	238.453325	230.616835	2.431
20	70	146.908	339.492738	308.3137	2.098
21	70	164.212	418.699598	385.222584	2.345
22	44	89.096	202.035596	180.411300	2.024
23	34	72.177	167.848683	153.22115	2.122
24	22	48.375	112.424869	106.37002	2.198
25	18	37.329	85.314401	77.414124	2.073
26	10	21.621	49.815225	46.746764	2.162
27	9	23.704	64.699942	62.43106	2.633
28	5	10.831	29.495049	23.46211	2.166
29	9	21.917	55.276051	53.37276	2.435
30-up	4	8.884	20.179898	19.731364	2.221
Total	350	780.318	1890.870858	1750.162177	