

Race and Gender Factors in ACT English and Composite Scores

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Abstract: *This study utilized quantitative research methods using the Montana Office of Public Instruction's Growth and Enhancement of Montana Students (GEMS) data set. This quantitative research is important because it provides insight on the following relationships (1) Is there a statistically significant difference among students from different races on their mean 11th grade ACT English scores?; (2) Is there an interaction between gender and race on students' mean 11th grade ACT English scores?; and (3) Is there a statistically significant difference among American Indian students mean ACT composite score from their Junior to their Senior year.*

Key Words: Race, Gender, ACT, American Indian or Native American

Acknowledgment: The author thanks Dr. Carrie Myers from Montana State University for providing valuable feedback. The author also thanks the journal editors, Dr. Bob Ives and Dr. Rod Case, and the anonymous reviewers for their insightful suggestions.

LITERATURE REVIEW

The ACT, previously known as the American College Test, is a standardized college entrance examination that Universities in the U.S. often utilize to select high school applicants for admission (Bauer & Wise, 2016). The ACT includes English, mathematics, reading, and science as the four major subject areas (Frey, 2018). Furthermore, each of these subject areas is graded on a scale of 1-36. The ACT composite score averages these four subject areas scores and rounded to the nearest whole number (Watson & Flamez, 2014; Brazill, 2019).

In fact, ACT scores in combinations with other factors can be used to predict college success and retention (Conley, 2008; Lotkowski, Robbins, and Noeth, 2004; Inzlicht & Ben-Zeev, 2000; Krueger & Whitmore, 2001). However, Bettinger, Evans, and Pope (2013) found that ACT English scores are strongly correlated with college success compared to other ACT test scores, such as ACT reading, math, or science scores.

Limited research has been done to show what factors predict ACT English Scores. This quantitative research paper fills that gap by examining factors that predict 11th Grade ACT English scores for Montana high school students. It provides valuable insights for schools to better prepare their students to achieve higher ACT English performance. Moreover, some high school students struggle with their ACT preparation, especially if they are females and minority students (Inzlicht and Ben-Zeev, 2000; Soares, 2015; Brazill, 2019; Brazill, 2020). Thus, this study selected race

and gender as two important independent variables. Furthermore, Native American students are the majority of minority students in Montana, where the data was collected (Ward, 1995).

DESIGN AND METHODOLOGY

The purpose of this study is to investigate and determine whether gender and race associate with students' ACT English and composite scores. It is important to understand what factors associate with students' ACT English and composite scores so educators can support students in their ACT preparation and help them to become college ready. It would also help us to understand if there is a statistically significant difference among American Indian students mean ACT composite score from their Junior to their Senior year.

The objectives are to examine the following relationships (1) Is there a statistically significant difference among students from different races on their mean 11th grade ACT English scores?; (2) Is there an interaction between gender and race on students' mean 11th grade ACT English scores?; and (3) Is there a statistically significant difference among American Indian students mean ACT composite score from their Junior to their Senior year. The unit of analysis is the 11th grade ACT English scores and ACT composite scores. The social phenomenon that I want to understand is how well do our public high school students from different races perform with their ACT English and composite scores. I am especially interested in how American Indian students' mean ACT composite scores differ from their Junior to their Senior year because Indian Education for All is a priority in Montana. As a multicultural educator, I want to be involved in American Indian research and provide strategies to support their learning and help these students succeed. I will describe the research questions, population and sample, study variables, statistical strategy, coding, level of measurement, and operationalization in details in the following sections.

RESEARCH QUESTIONS

Research question 1: Is there a statistically significant difference among American Indian, Hispanic, White, and Others on their mean 11th grade ACT English scores? This research question is used to examine the relationship between the independent variable race (Hispanic, American Indian, White, and Others) and the dependent variable (mean 11th grade ACT English scores).

Research question 2: Is there a difference in the means of 11th grade ACT English scores of each race category while controlling for gender?

Research question 3: Is there a difference in the means of 11th grade ACT English scores of each gender category while controlling for race?

Research question 4: Is there an interaction between gender and race on mean 11th grade ACT English scores? This research question is used to examine whether there is an interaction between the independent variables race (Hispanic, American Indian, White, and Others) and gender (male or female) on the dependent variable (mean 11th grade ACT English scores).

Research question 5: Is there a statistically significant difference between American Indian students' mean ACT composite score from their Junior to their Senior year? This research question is used to examine the relationship between the independent variable (race, i.e. American Indian) and the dependent variable (mean ACT composite scores at Time 1 (Junior) and Time 2 (Senior)).

POPULATION AND SAMPLE

The population is 8887 high school seniors in the 2015 – 2016 academic year who entered postsecondary education in a Montana institution in 2016 – 2017. A random sample of 300 participants was available. Table 1 illustrates relevant demographic statistics and descriptive data of the sample characteristics.

Table 1: Descriptive Data and Demography Statistics of the Sample Characteristics

Gender	
Males	144 (48%)
Females	156 (52%)
Total	300
Race	
Hispanic	14 (5%)
American Indian	14 (5%)
White	265 (88%)
Others	7 (2%)
Total	300

As shown in Table 1, this study includes 156 female and 144 male student participants. Fourteen people identified themselves as Hispanic, 14 are American Indian, 265 are white, and 7 people fall into the categories of Others. I ran a cross tab for race and gender as shown in Table 2 (Hispanic is coded as “1”, American Indian is coded as “2”, White is coded as “3”, and Others is coded as “4”.)

Table 2: Cross Tab for Race and Gender

RaceEthnicityFed	gender		Total
	F	M	
1	16.909091	16.666667	16.857143
	3.1130225	3.5118846	3.0598427
	11	3	14
2	15.142857	15.428571	15.285714
	4.3752551	3.258688	3.7092104
	7	7	14
3	21.408759	20.117188	20.784906
	5.7067488	5.2536018	5.5201901
	137	128	265
4	17	20	19.571429
	0	4.9396356	4.6496288
	1	6	7
Total	20.782051	19.8125	20.316667
	5.7342152	5.2169288	5.5043056
	156	144	300

STUDY VARIABLES

As shown in Table 3 below, for research question 1 and 2 (Is there a statistically significant difference among Hispanic, American Indian, White, and Others on their mean 11th grade ACT English scores? and Is there a difference in the means of 11th grade ACT English scores of each race category while controlling for gender?), the independent variable is race, which consists of the categories Hispanic, American Indian, White, and Others. It is a categorical/nominal variable. Hispanic is coded as “1”, American Indian is coded as “2”, White is coded as “3”, and Others is coded as “4”. The dependent variable is 11th grade students’ ACT English scores, the scores range from 1-36, and it is a continuous variable measured at the ratio level. ACT scores is used as a measure of learning. The control variable is gender for research question 2.

For research question 3 (Is there a difference in the means of 11th grade ACT English scores of each gender category while controlling for race?), the independent variable is gender, male is coded as “1” and female is coded as “2”. The control variable is race.

For research question 4 (Is there an interaction between gender and race on mean 11th grade ACT English scores?), the first independent variable is race (Hispanic, American Indian, White, and Others) and it is a categorical/nominal variable. Hispanic is coded as “1”, American Indian is coded as “2”, White is coded as “3”, and Others is coded as “4”. The second independent variable is gender (male or female) and it is a categorical/dichotomous variable. Male is coded as “1” and female is coded as “2”. The dependent variable is the mean 11th grade ACT English scores, the scores range from 1-36, and it is a continuous variable measured at the ratio level.

For research question 5 (Is there a statistically significant difference between American Indian students mean ACT composite score from their Junior to Senior year?), the independent variable is race (American Indian), and it is a categorical/nominal variable. The dependent variable is mean ACT composite scores at Time 1 (Junior) and Time 2 (Senior). The scores range from 1-36, and it is a continuous variable measured at the ratio level.

Table 3: Study Variables

Research Question 1				
	Variable Name	Operational Definition	Coding	Level of Measurement
Independent variable	Race	Hispanic, American Indian, White, and Others	Hispanic = 1 American Indian =2 White=3 Others=4	Categorical/Nominal
Dependent variable	ACT English 11	Mean 11 th grade ACT English scores	1-36	Continuous
Research Question 2,3, &4				
	Variable Name	Description	Coding	Level of Measurement
Independent variable	Race	Hispanic, American Indian, White, and Others	Hispanic = 1 American Indian =2 White=3 Others=4	Categorical/Nominal

Independent variable	Gender	Male and Female	Male = 1 Female = 2	Categorical/ Dichotomous
Dependent variable	ACT English 11	Mean 11 th grade ACT English scores	1-36	Continuous

Research Question 5

	Variable Name	Description	Coding	Level of Measurement
Independent variable	Race	Hispanic, American Indian, White, and Others	Hispanic = 1 American Indian =2 White=3 Others=4	Categorical/Nominal
Dependent variable	ACT Composite scores	Mean ACT composite scores at Time 1 (Junior) and Time 2 (Senior)	1-36	Continuous

STATISTICAL STRATEGY

Urdan (2011), Acock (2018), and Mehmetoglu & Jakobsen (2017) were the foundations for the analytical approach for this research. For research question 1, one-way analysis of variance (one-way ANOVA) was chosen to compare the means of two or more groups (the independent variable, i.e. American Indian, Hispanic, White, and Others) on one dependent variable (ACT English 11th grade scores) to see if the group means are significantly different among each other (Urdan, 2011). For research question 2, 3, and 4, factorial ANOVA was used because there was one continuous (i.e., interval or ratio scaled) dependent variable (mean 11th grade ACT English scores) and two or more categorical/nominal independent variables (race and gender) (Urdan, 2011). For research question 5, a repeated-measures ANOVA was used when there is a single group (e.g., American Indian students) with two scores (e.g., Junior, Senior) on a single dependent variable (e.g., mean ACT composite) (Urdan, 2011).

According to Urdan (2011), post hoc tests are statistical tests conducted after obtaining the overall F value from the ANOVA to make pairwise comparison for each group mean to the other group means while controlling the number of comparisons being made. I chose Bonferroni Post Hoc study for the ANOVA since it is best when there is a small number of comparisons (Mehmetoglu & Jakobsen, 2017).

PREPARING THE DATA

One data preparation strategy was recoding the race groups. Originally, the data was coded as “1-Hispanic, 2-American Indian, 3-Asian, 4-Black or African American, 5-Native Hawaiian, and 6-White, 7-two or more race”. There are 0 Black/African American, 0 Native Hawaiian, only 2 Asian, and 5 from two or more race. I combined Asian and two or more races and recoded the dataset as “1- Hispanic, 2- American Indian, 3-White, 4-Others”. The coding for gender originally was “M” and “F” which was converted to Male as “1” and Female as “2”. Also, I reformatted/reshaped the data for repeated measures ANOVA by creating a new Excel spreadsheet, by separating out the American Indian students and including 3 columns (ID for each student, grade level, and ACT Composite Scores). The reorganization of data makes it possible to conduct

the analysis in Stata. As shown in Table 4, I ran descriptive statistics on all variables based on the sample to be analyzed.

Table 4: Descriptive Statistics

RaceEthnicityFed	gender		Total
	F	M	
1	16.909091	16.666667	16.857143
	3.1130225	3.5118846	3.0598427
	11	3	14
2	15.142857	15.428571	15.285714
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4	17	20	19.571429
	0	4.9396356	4.6496288
	1	6	7
Total	20.782051	19.8125	20.316667
	5.7342152	5.2169288	5.5043056
	156	144	300

I calculated power analysis based on the given sample size. The .80 is the power and delta is the effect sizes for the different sample size (Mehmetoglu & Jakobsen, 2017). Delta showed the sample size that is needed to achieve the different effect sizes given an alpha of .05 and power at 80% (See Table 5).

Table 5: Power Test Result

alpha	power	N	N_per_group	delta	N_g	Var_m	Var_e
.05	.8	1,096	274	.1	4	.01	1
.05	.8	492	123	.15	4	.0225	1
.05	.8	280	70	.2	4	.04	1
.05	.8	180	45	.25	4	.0625	1
.05	.8	128	32	.3	4	.09	1
.05	.8	96	24	.35	4	.1225	1
.05	.8	76	19	.4	4	.16	1
.05	.8	60	15	.45	4	.2025	1
.05	.8	48	12	.5	4	.25	1
.05	.8	44	11	.55	4	.3025	1
.05	.8	36	9	.6	4	.36	1
.05	.8	32	8	.65	4	.4225	1
.05	.8	28	7	.7	4	.49	1
.05	.8	24	6	.75	4	.5625	1
.05	.8	24	6	.8	4	.64	1

RESULTS

Research question 1: Is there a statistically significant difference among Hispanic, American Indian, White, and Others on their mean 11th grade ACT English scores?

A one-way ANOVA was conducted to test research question 1 to determine if ACT English average scores were significantly different for groups from different races on a sample of 300 observations from 11th grade students. As shown in Table 6, participants were split into four groups based on race: Hispanic (n=14), American Indian (n=14), White (n= 265), and Others (n=7). In Table 7, the results of the test show that Hispanic (M =16.86, SD=3.06, n=14), American Indian (M =15.29, SD=3.71, n=14), White (M =20.78, SD=5.52, n=265), and Others (M =19.57, SD=4.65, n=7). There is a significant difference in the 11th grade English ACT scores between Whites and Hispanics. On average Whites have a higher mean 11th grade English ACT score(M=20.78) compared to Hispanics (M=16.86). Likewise, there is a significant difference in the 11th grade English ACT scores between Whites and American Indian. On average Whites have a higher mean 11th grade English ACT score(M=20.78) compared to American Indian (M=15.29).

Table 6: Descriptive Statistics of Different Race ACT English Average Scores

Race	Hispanic	American Indian	White	Others
Mean	16.86	15.29	20.78	19.57
Standard Deviation	3.06	3.71	5.52	4.65
Number of Observations	14	14	265	7

The results in Table 7 show that there was a statistically significant difference between groups as determined by one-way ANOVA ($F(3,296) = 6.80, p=.0002$). With a p value smaller than .05, there is strong evidence against the null hypothesis, so the test rejects the null hypothesis. Therefore, there is a statistically significant difference among Hispanic, American Indian, White, and Others on their mean 11th grade ACT English scores.

Table 7: One-way ANOVA Result (Research Q1)

RaceEthnicityFed	Summary of ACTEnglish11			F	Prob > F
	Mean	Std. Dev.	Freq.		
1	16.857143	3.0598427	14		
2	15.285714	3.7092104	14		
3	20.784906	5.5201901	265		
4	19.571429	4.6496288	7		
Total	20.316667	5.5043056	300		

Source	Analysis of Variance			F	Prob > F
	SS	df	MS		
Between groups	583.89133	3	194.630443	6.80	0.0002
Within groups	8475.02534	296	28.6318424		
Total	9058.91667	299	30.2973802		

Bartlett's test for equal variances: $\chi^2(3) = 8.9758$ Prob> $\chi^2 = 0.031$

Comparison of ACTEnglish11 by RaceEthnicityFed (Bonferroni)			
Row Mean- Col Mean	1	2	3
2	-1.57143 1.000		
3	3.92776 0.047	5.49919 0.001	
4	2.71429 1.000	4.28571 0.508	-1.21348 1.000

Bartlett's post hoc test results indicate that the group mean difference between group 3 (White) and group 1 (Hispanic) is significant with a p value smaller than .05 ($p=.0047$). The group mean difference between group 3 (White) and group 2 (American Indian) is significant with a p value smaller than .05 ($p=.0001$). Group 3 (White) and group 2 (American Indian) mean difference is 5.50 which is higher than mean difference of 3.93 between group 3 (White) and group 1 (Hispanic).

Research question 2: Is there a difference in the means of 11th grade ACT English scores of each race category while controlling for gender?

Research question 3: Is there a difference in the means of 11th grade ACT English scores of each gender category while controlling for race?

Research question 4: Is there an interaction between gender and race on mean 11th grade ACT English scores?

A two-way ANOVA was run on a sample of 300 participants to examine the effect of gender and race on mean 11th grade ACT English scores. The results in Table 8 show that main effect 1 (race when controlling for gender) is significant with a p value smaller than .05 ($p=0001$). Main effect 2 (gender when controlling for race) is not significant with a p value larger than .05 ($p=.0710$.) The results in Table 9 show that there was no significant interaction effect of gender and race on mean 11th grade ACT English scores, $F(3, 292) = 0.29$, $p=.08299$. With a p value larger than .05, we fail to reject the null hypothesis. Therefore, there is no relationship between gender and mean 11th grade ACT English scores when controlling for race for main effect 2.

Table 8: Two-Way Factorial ANOVA Test for Two Main Effects for Race and Gender (Research Q2 and Research Q3)

Source	Partial SS	df	MS	F	Prob>F
Model	677.19847	4	169.29962	5.96	0.0001
RaceEthni~d	606.80904	3	202.26968	7.12	0.0001
gender	93.307138	1	93.307138	3.28	0.0710
Residual	8381.7182	295	28.412604		
Total	9058.9167	299	30.29738		

Table 9: Two-Way Factorial ANOVA Test for Interaction (Research Q4)

Source	Partial SS	df	MS	F	Prob>F
Model	702.4178	7	100.3454	3.51	0.0013
RaceEthni~d	535.56345	3	178.52115	6.24	0.0004
gender	1.622065	1	1.622065	0.06	0.8120
RaceEthni~d#gender	25.219337	3	8.4064455	0.29	0.8299
Residual	8356.4989	292	28.618147		
Total	9058.9167	299	30.29738		

Research questions 5: Is there a statistically significant difference between American Indian students' mean ACT composite score from their Junior to their Senior year?

A repeated measures ANOVA was run on a sample of 14 participants to determine if there were statistically significant difference among American Indian students' mean ACT composite scores from their Junior to Senior year. The results in Table 10 show that there are no statistically significant differences in mean ACT composite score from their Junior to Senior year, $F(1, 13) = 1.00$, $p=0.3356$. With a p value larger than .05, we fail to reject the null hypothesis. Therefore, there is no statistically significant difference between American Indian students mean ACT composite score from their Junior to Senior year.

Table 10: Repeated Measures ANOVA Result (Research Q5)

Source	Partial SS	df	MS	F	Prob>F
Model	379	14	27.071429	47.38	0.0000
ID	378.42857	13	29.10989	50.94	0.0000
GradeLvl	.57142857	1	.57142857	1.00	0.3356
Residual	7.4285714	13	.57142857		
Total	386.42857	27	14.312169		

Number of obs =	28	R-squared =	0.9808
Root MSE =	.755929	Adj R-squared =	0.9601

Between-subjects error term:	ID	
Levels:	14	(13 df)
Lowest b.s.e. variable:	ID	

Repeated variable:	GradeLvl	
	Huynh-Feldt epsilon	= 1.0000
	Greenhouse-Geisser epsilon	= 1.0000
	Box's conservative epsilon	= 1.0000

Source	df	F	Prob > F			
			Regular	H-F	G-G	Box
GradeLvl	1	1.00	0.3356	0.3356	0.3356	0.3356
Residual	13					

DISCUSSIONS AND CONCLUSIONS

For research question 1, research results indicate that there is a statistically significant difference among American Indian, Hispanic, White, and Others on their mean 11th grade ACT English scores. Pairwise comparisons show that the mean difference between White and American Indian is significant and even higher than between White and Hispanic. The result aligns with Soares’ (2015) finding, which indicates that race is associated with ACT scores. For example, American Indian students have lower average ACT scores compared to White Americans. An alternative explanation could be test anxiety. In other words, perhaps some races are more prone to test anxiety, for example because of a cultural background where competitive testing is not practiced. Another alternative explanation might be previous knowledge prior to taking the ACT English test. In essence, some cultures (as reflected in race) have more previous knowledge prior to taking the ACT text, for example because of a cultural emphasis on knowing about tests, parents having taken similar tests, etc. Another possible explanation is socio-economic status. To be specific, some races may be relatively richer or poorer than others, with these affecting things such as better schools, more highly paid and more experienced teachers, ability to take test prep courses, and ability to obtain tutors, etc.

For research question 2, 3, and 4, results indicate that gender has no significant effect on mean 11th grade ACT English scores when controlling for race. The lack of significant effect might be explained by English levels prior to taking the ACT English test, school size, and socio-economic status. Surprisingly, the research results indicate that there may not be as much of a difference between male and female test performance as is often assumed in the literature review. The data and analysis demonstrate that male and female are equally good at the ACT English test for 11th grade. One limitation of the data, however, is that there are only 300 samples, and perhaps more observations would generate a different outcome.

For research question 5, research results show that there is no statistically significant difference between American Indian students mean ACT composite score from their Junior to Senior year. This could be because of data limitations, with only a small sample of American Indians (n=14). Maybe more observations would generate a different outcome. However, High schools and individual educators are expected to help students improve their ACT scores.

Practitioners and researchers should have a better understanding of this topic and support students for their pre-college experience by (1) Investigating programs and support systems to help high school students improve their ACT English and composite scores; and (2) Investigating other factors that might associate with students ACT English and composite scores. By examining these data, for future research, educators and researchers can develop teaching and learning strategies to improve students' overall ACT scores and help students from different races better identify strategies to improve their ACT scores in order to become college ready.

REFERENCES

- Acock, C.A., (2018). A gentle introduction to Stata. Texas: Stata Press.
- Ashlee, A. A., & Ashlee, K. C. (2015). *VITAL: A Torch For Your Social Justice Journey*. Cincinnati, OH: Brave Space Publishing.
- Bettinger, E. P., Evans, B. J., & Pope, D. G. (2013). Improving college performance and retention the easy way: Unpacking the ACT exam. *American Economic Journal: Economic Policy*, 5(2), 26-52.
- Brazill, S. C. (2019). Factors that Predict ACT Science Scores from a Multicultural Perspective. *Educational Research: Theory and Practice*, 30(2), 1-16.
- Brazill, S. C. (2019). "The Relationship of Gender, School Attendance, and Grade Level with ACT English and Composite Test Scores." In *Global Learn 2019 Conference*. Association for the Advancement of Computing in Education (AACE).
- Brazill, S. (2020, April). Factors that Predict 12th Grade ACT STEM Scores and Implications for Teacher Education. In *Society for Information Technology & Teacher Education International Conference* (pp. 843-849). Association for the Advancement of Computing in Education (AACE).
- Budden, M. C., & Hsing, Y. (2006). Impacts of accountability indicators and socioeconomic factors on test scores and policy implications. *Journal of College Teaching and Learning*, 3(4), 21-25.
- Conley, D. T. (2008). *College knowledge: What it really takes for students to succeed and what we can do to get them ready*. John Wiley & Sons.
- Frey, B. B. (Ed.). (2018). *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation*. SAGE Publications.
- Howe, W. A., & Lisi, P. L. (2013). *Becoming a multicultural educator: Developing awareness, gaining skills, and taking action*. California: Sage.
- Inzlicht, M., & Ben-Zeev, T. (2000). A threatening intellectual environment: Why females are susceptible to experiencing problem-solving deficits in the presence of males. *Psychological Science*, 11(5), 365-371.
- Krueger, A. B., & Whitmore, D. M. (2001). The effect of attending a small class in the early grades on college-test taking and middle school test results: Evidence from Project STAR. *The Economic Journal*, 111(468), 1-28.

- Lotkowski, V. A., Robbins, S. B., & Noeth, R. J. (2004). The Role of Academic and Non-Academic Factors in Improving College Retention. ACT Policy Report. *American College Testing ACT Inc.*
- Maruyama, G. (2012). Assessing college readiness: Should we be satisfied with ACT or other threshold scores?. *Educational Researcher*, *41*(7), 252-261.
- Mehmetoglu, M., & Jakobsen, T. G. (2016). *Applied statistics using Stata: a guide for the social sciences*. California: Sage.
- Rooney, C., & Schaeffer, B. (1998). Test Scores Do Not Equal Merit: Enhancing Equity & Excellence in College Admissions by Deemphasizing SAT and ACT Results.
- Soares, J. A. (2015). *SAT wars: The case for test-optional college admissions*. Teachers College Press.
- Urduan, T.C., (2011). *Statistics in plain English*. New York: Routledge.
- Ward, C. (1995). American Indian High School Completion in Rural Southeastern Montana 1. *Rural Sociology*, *60*(3), 416-434.