Education in America and Korea

For this project I chose to examine the educational differences between America and South korea as well as the effect of stress on students. In recent years, American education as been under a spotlight of scrutiny. Our teachers feel unappreciated and underpaid, and our Mathematics and Science scores are embarrassingly low compared to our global counterparts. An example of this is shown through the examinations given by PISA every three years. For the readers who are unfamiliar, PISA (Programme for International Student Assessment) is an organization that tests the skill level of fifteen year old students internationally across five disciplines: science, mathematics, reading, collaborative problem solving and financial literacy.[1] The most recent data collected from the PISA exam regarding the average math scores for all tested countries shows that the average score for all countries involved (490) and the score for South Korea (524) are both significantly larger than America's score (470) at the .05 significance level.[2]

Here, I would like to note some background information about the school systems of both countries that led me to form my initial hypotheses.

First, the time spent in school differs for both countries. Korean Students generally have six years of primary school and three years of middle school, followed by three years of highschool. A regular school day for a highschool student begins at 7am and ends at 5pm (with classes

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[1]"About - PISA." *Students, Computers and Learning - Making the Connection - En - OECD*, 2018, www.oecd.org/pisa/aboutpisa/.

[2] "Program for International Student Assessment (PISA) - Mathematics Literacy: Average Scores." *Revenues and Expenditures for Public Elementary and Secondary Education: School Year 2001-2002, E.D. Tab*, nces.ed.gov/surveys/pisa/pisa2015/pisa2015highlights_5.asp.

running from 8am to 4 or 4:30 pm). Students generally arrive at school early to study and then stay after to clean the classroom before leaving. After having a snack or stopping home for dinner a student generally goes to a private tutor, a study session, or the library to study individually until about 10 pm.[3] At each level, students are required to attend 220 days of schooling a year. The school year generally consists of two semesters; one from March through July and one from September through May with a thirty day summer break in between. This break, however is often reduced to just ten days for most students, as many of them choose to attend optional half day classes offered during the first ten days of break and the last ten days of break.

In America, the situation is slightly different. There are five years of primary school (excluding Kindergarten, as it is not required everywhere), three years of middle school, and four years of highschool; the same number of school years as South Korea, but distributed differently. A typical school day in America consists of students arriving about a half hour before classes begin to finish homework assignments or finish any last minute studying for exams. Classes generally run from about 8 am to 3 pm. After school students either go to after school clubs or to the library to finish homework or study until about 4pm or 6pm. Later, many students go home and continue to do homework until late into the night. Like korea, the year is divided into two semesters; one from August through December and one from January through May. The difference here is that American Students generally have three breaks

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[3] Diem, Richard, et al. “South Korean Education.” *Asia Society*, Asia Society, 2018, asiasociety.org/global-cities-education-network/south-korean-education.

consisting of 30 days in winter, 7 days in Spring, and sixty days in Summer. Also, only students who have failed classes during the school year attend classes over the summer.

Secondly, there are differences in how teachers in each country are selected and treated. In korea, more focus is placed on selection of new teachers rather than recruitment. They have a surplus of qualified candidates who want the position, and so are able to select the best qualified out of that group. In America, on the other hand, there are generally not enough qualified candidates who want the teaching position, so more attention is given to recruiting teachers. An example of this practice is the implementation of the ACP certification in some states. This certification allows adults who have already specialized in a subject (earned a degree) to become a certified teacher through a Summer course and two years of on the job training. Candidates who teach math, science, or special education also receive loan forgiveness up to $17,500.[4] Unfortunately, this is not enough for many students from top colleges to repay their loans, and the teaching profession loses these top candidates to more lucrative and well-paying careers. In fact, many of America's teachers come from the bottom two thirds of their college classes, and in more poverty stricken areas, from the bottom third.[5]

Finally, there are major differences in how each country views and values education. This was evident to me each

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[4] Sclafani, Susan F. "How the World Recruits Teachers." *Asia Society*, Asia Society, asiasociety.org/global-cities-education-network/how-world-recruits-teachers.

[5] Cohn, Jonathan. "Paying Teachers Too Much? Or Too Little?" *The New Republic*, 7 Mar. 2011, newrepublic.com/article/84780/teacher-pay-international-comparison-usa-korea.

country's educational mission statements. The Korean Ministry of Education stated that their goal was "to improve basic abilities, skills and attitudes; to develop language ability and civic morality needed to live in society; to increase the spirit of cooperation; to foster basic arithmetic skills and scientific observation skills; and to promote the understanding of healthy life and the harmonious development of body and mind."[6] The mission statement of the US Department of Education is to "promote student achievement and preparation for global competitiveness by fostering educational excellence and ensuring equal access."[7] It sounded to me as if America only cared about education in the sense of staying ahead of its competitors and that Korea actually saw value in education and its effect on human beings.

The Experiment

Hypotheses

After researching the Korean education system, I found many similarities to American colleges. First, our college professors are paid significantly more than our public high school teachers and are specialised in the subject area they teach. Secondly, American college students spend more time studying than American high school students. In highschool, more time is spent completing homework than actually studying. In college, students generally study consistently throughout the year both before and after classes each day until late into the evening. Third, students in college

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[6] Diem, Richard, et al. "South Korean Education." *Asia Society*, Asia Society, 2018, asiasociety.org/global-cities-education-network/south-korean-education.

[7] "Mission." *Home*, US Department of Education (ED), 20 Oct. 2011, www2.ed.gov/about/overview/mission/mission.html.

generally pay for their own education as well as study a subject which actually interests them. Therefore they tend to see actual value in what their learning. I would like to make it clear here that these are generalizations and not every student in America or Korea follows this previously mentioned trends. From this, I hypothesised that if the students, teacher, attitudes, and study habits in American Colleges are more aligned with their Korean counterparts than American High Schools, that the disparity in math skill will lessen or disappear. That is, there would be no difference in math test scores.

Other research that influenced my preliminary hypothesis for this experiment was that on the effect of stress on testing ability. The most notable article was *The Effect of Time Constraints and Statistics Test Anxiety on Test Performance in a Statistics Course,* written by Anthony J. Onwuegbuzie and Michael A. Seaman in The Journal of Experimental Education.[8] Two types of students were tested: those with testing anxiety and those without testing anxiety. Both types were given a timed and untimed versions of the test. While students without testing anxiety performed equally well on the timed and untimed exam, students with testing anxiety received a whole letter grade lower on the timed exam. Although I would not be able to separate out students with and without testing anxiety in my study, I was still very interested in the effect stress had on the test scores of both the Korean and American students.

Design

For this experiment, I was interested in both how the country in which a person was

[8] Onwuegbuzie, Anthony J. "The Effect of Time Constraints and Statistics Test Anxiety on Test Performance in a Statistics Course." *The Journal of Experimental Education*, The Journal of Experimental Education, 1 Jan. 1995, www.jstor.org/stable/20152442?seq=7#page_scan_tab_contents.

educated in as well as how stress level affects the test-taking ability of the person. I chose, therefore to run a two-factor fixed factorial experiment. Factor A is nationality, or country in which a participant completed his compulsory education. There are two levels: Korean and American. Factor B is the stress level. There are two levels here as well: timed and untimed. The participants given the timed test were allotted seven minutes to complete the exam. Four different tests were created using qualtrics. They consisted of eight questions pulled from the math portion of the American ACT. The full math ACT has sixty questions that increase in difficulty every fifteen questions. Therefore, I chose two question at random from each section of fifteen questions to create a shorter simulation of the real test that more students would be willing to take. All four tests contained the same set of questions. There was a korean and an English version.[9] One test in each language was timed to simulate stressful conditions during the test. The ACT generally gives sixty seconds per question. I gave seven minutes for the timed test, or 52.5 seconds per question. I gave slightly less because I wanted to ensure that the test taker felt stressed while trying to complete the problems. In all, therefore, there was a Korean timed test, a Korean untimed test, an English timed test, and an English untimed test.

It is important to note that since it is a fixed design, my results only apply to Korean and American students, and timed and untimed samples of the ACT exam.

Sample Collection

My requirements for the test subjects I collected were as follows:

[9] All translations were done by Geom Je.

Korean participants must have completed compulsory education in Korea. American students must have completed compulsory education in America. Because the disparity occurs at the highschool level, it should not matter if the korean students attend college in America or Korea. In other words, if one group of students scored better in the past as a result of a different compulsory education system, does that advantage remain or does it fade. I am testing if Korean and American college students are on equal skill level at the college level even after being behind in high school. As long as all participants had or currently were attending college in Korea or America, they were considered valid. I would have liked to include other countries in my study, however, I was not able to find sufficient volunteers. In order to find participants for my study, I chose korea because it is the only country I have contacts in to be able to solicit volunteers for my study. I originally wanted to include French students in the study as well, but I could not find enough volunteers. In order to collect test subjects, I used a variety of tactics. My first option was to hand out free donuts and cookies in exchange for taking one of my tests. Next, I posted notes on the International floors of the student dorms. When this gave no results, I posted on the International Students Facebook page. In conjunction with this, I called my friends in Korea to ask if they would hand out my information as well. Unfortunately, I have to assume that all test subjects were telling the truth when they indicated they met my requirements because I could not meet many of them in person.

In order to properly minimize type II error with respect to nationality and the stress/no stress condition as well as the interaction between the two factors, the

following formulas were used, and tables created based off of the OC curve.

In this case,

$$b = 2, a = 2, D = 5, and\ \sigma^2 = 5.3$$

.[10] In regards to factor A we use $\frac{bnD^2}{2a\sigma^2}$ and the OC curve to create the table,

n	Φ^2	Φ	v_1 = numerator degrees of freedom	v_2 = denominator degrees of freedom	β
4	1.78	1.33	1	12	~.55
5	2.22	1.49	1	16	~.55
10	4.45	2.11	1	20	~.21
15	6.67	2.58	1	56	~.06

In regards to factor B, we use $\frac{anD^2}{2b\sigma^2}$ and the OC curve to create the table:

n	Φ^2	Φ	v_1 = numerator degrees of freedom	v_2 = denominator degrees of freedom	β
5	1.11	1.05	1	16	~.60
10	2.22	1.49	1	20	~.55
15	3.34	1.83	1	56	~.22
30	6.67	2.58	1	116	~.06

In regards to the interaction between factor A and factor B, we use $\frac{nD^2}{2\sigma^2[(a-1)(b-1)+1]}$ and the OC curve to create the table:

n	Φ^2	Φ	v_1 = numerator degrees of freedom	v_2 = denominator degrees of freedom	β
4	1.78	1.33	1	12	~.55
5	2.22	1.49	1	16	~.55
10	4.45	2.11	1	20	~.21
15	6.67	2.58	1	56	~.06

From these tables, we can conclude that the ideal sample size for my test would be between 15 and 30 students. This would minimize the type II error and therefore give the highest power of the test. Due to limited

[10] 5.3 is the standard deviation of all participants of the most recent ACT exam. 5 is the maximum difference in which I am interested in,

amounts of test subjects available, however, I had to settle for five participants for each test. Therefore, the power of my test is only around 45%.

Data Collection

Ideally, all twenty of my subjects would have been chosen randomly first, then placed into a list. Then that lists would be randomized and the tests run in that new random order. An example of this is shown below.

Original List of Participants

1. Korean, Stress, 1
2. Korean, Stress, 2
3. Korean, Stress, 3
4. Korean, Stress, 4
5. Korean, Stress, 5
6. Korean, No Stress, 1
7. Korean, No Stress, 2
8. Korean, No Stress, 3
9. Korean, No Stress, 4
10. Korean, No Stress, 5
11. American, Stress, 1
12. American, Stress, 2
13. American, Stress, 3
14. American, Stress, 4
15. American, Stress, 5
16. American, No Stress, 1
17. American, No Stress, 2
18. American, No Stress, 3
19. American, No Stress, 4
20. American, No Stress, 5

Randomized List of Participants

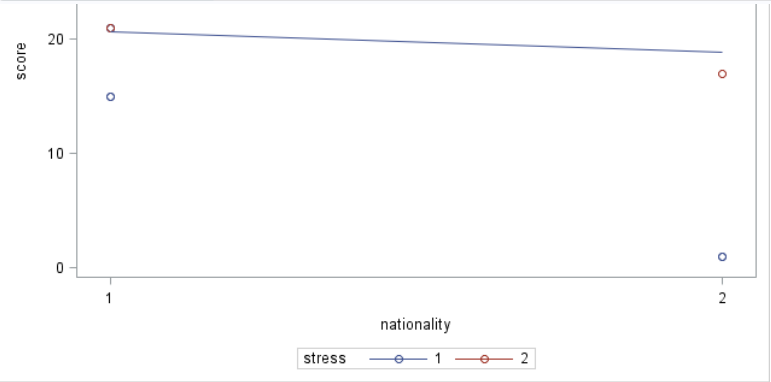
1. American, Stress, 5
2. Korean, No Stress, 5
3. American, No Stress, 2
4. Korean, Stress, 5
5. Korean, Stress, 3
6. American, No Stress, 3
7. American, Stress, 3
8. Korean, Stress, 2
9. American, No Stress, 1
10. American, Stress, 1
11. Korean, Stress, 4
12. American, Stress, 2
13. Korean, Stress, 1
14. Korean, No Stress, 3
15. Korean, No Stress, 4
16. American, No Stress, 5
17. Korean, No Stress, 2
18. Korean, No Stress, 1
19. American, Stress, 4
20. American, No Stress, 4

This, however, was not entirely possible do to the constraint that all test subjects had to volunteer for the test. Because I practically had to beg people to take my test, I was not able to control the order in which they were taken. Because most were taken online, however, I like to think that the collection process was still moderately random.

Upon the collection of the scores, I scaled them back to their ACT equivalents. And then put the new scaled scores into a table to run an analysis. This is shown in the tables below.

Ra		Stress Level		
	Nationality	Timed		Untime
8	Korean	15		36
7		21		25
6		21	103	28
5		31		21
		15		36
4	American	25		36
3		1		17
		1	94	36
2		36		31
1		31		28
	y.j	197		294

Source	DF	Type I SS	Mean Square	F Value	Pr > F
nationality	1	2.4500000	2.4500000	0.02	0.8816
stress	1	470.4500000	470.4500000	4.40	0.0523
nationality*stress	1	6.0500000	6.0500000	0.06	0.8151



Results

The relevant hypotheses for my analysis are stated below.

$$H_0: \tau_{Korean} = \tau_{American} = 0$$

$$H_A: at\ least\ one\ \tau_i \neq 0$$

$$H_0: \beta_{Timed} = \beta_{Untimed} = 0$$

$$H_A: at\ least\ one\ \beta_j \neq 0$$

$$H_0: at\ least\ one\ (\tau\beta)_{ij} = 0$$

$$H_A: at\ least\ one\ (\tau\beta)_{ij} \neq 0$$

The ANOVA table is shown fully calculated below, as well as the interaction plot.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	478.950000	159.650000	1.49	0.2546
Error	16	1712.000000	107.000000		
Corrected Total	19	2190.950000			

Because the p-value for effects due to nationality and the p value for the interaction effect between nationality and stress are so large, we fail to reject our null hypotheses. There is no indication of any significant effect of nationality, or country in which the student was educated in, on score. There is also no evidence that the effect of stress on score is different for either level of the nationality factor. This supports my hypothesis that the scores of students educated in America and students educated in Korea would be the same. Our p value for the effect of stress, however, was fairly low. At just higher than the .05 significance level, we reject our null hypothesis (we still fail to

reject at the .05 significance level, but just barely). There is evidence that stress level has an effect on the scores of American and Korean students taking the basic skills math exam (ACT).

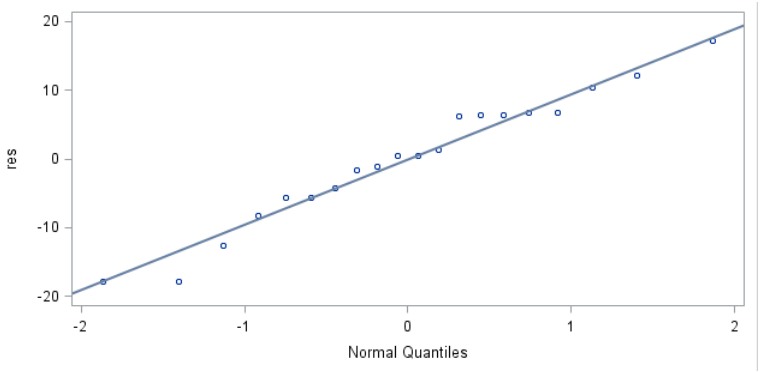
As we have already discussed there is no evidence of an interaction effect between nationality and stress on students test score. This is further shown in the interaction plot, as there are no intersecting lines. In other words, the effect of stress level on score is not affected by the country in which a student was educated.

Model Adequacy Checking

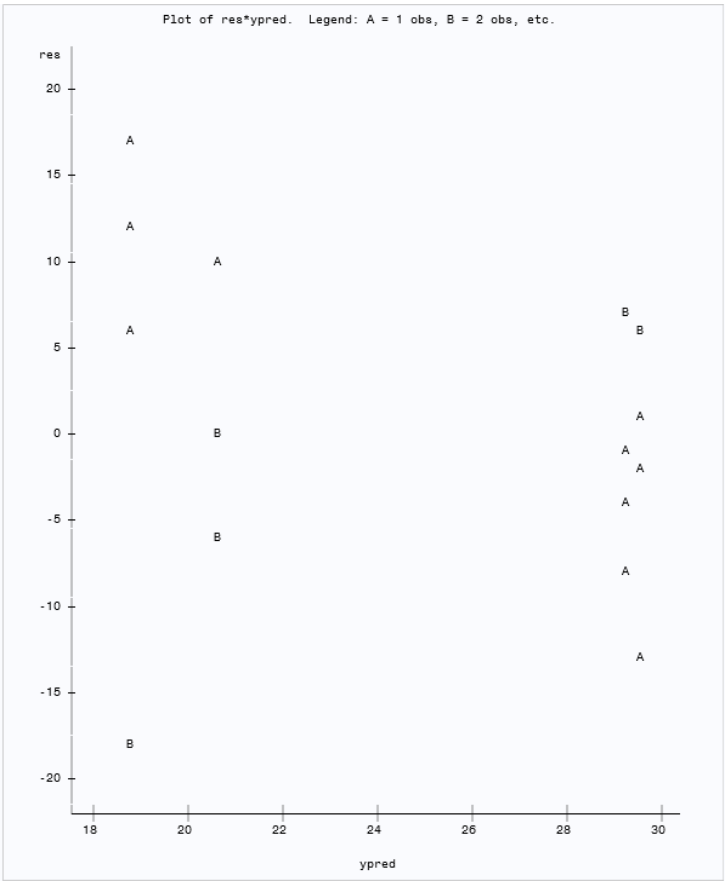
Before we accept our results, we must first check to ensure that our data is normally distributed with equal variance. First, we check the normality assumption. The SAS output is shown below.

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.965712	Pr < W	0.6630
Kolmogorov-Smirnov	D	0.143172	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.041471	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.280785	Pr > A-Sq	>0.2500

The p-value for the Shapiro-Wilk test, as well as the other tests for normality are all sufficiently large. Also, all data points are



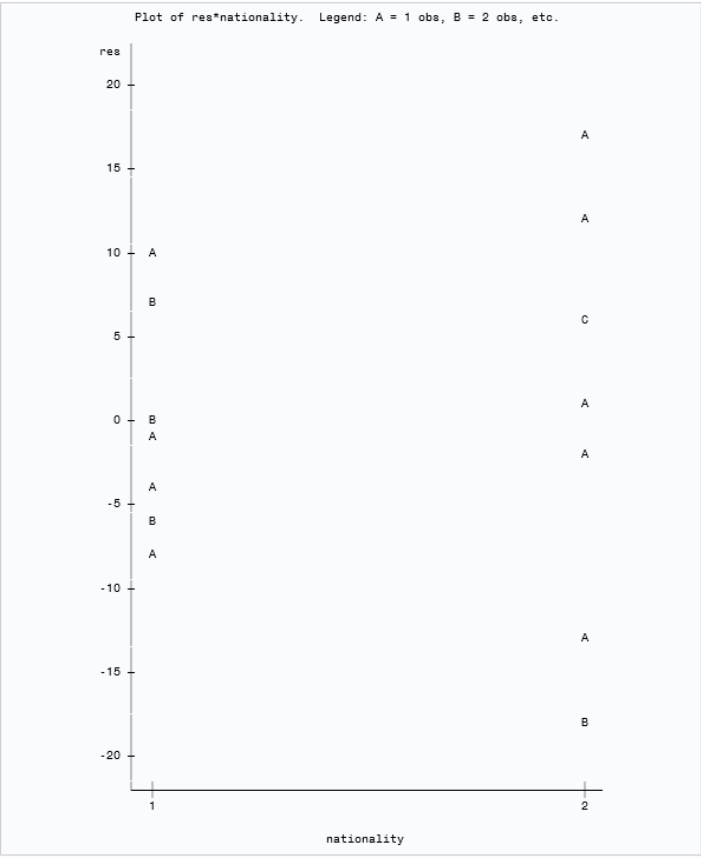
close to the normal line. Therefore, we can fail to reject the null hypothesis that the the data is not normally distributed and



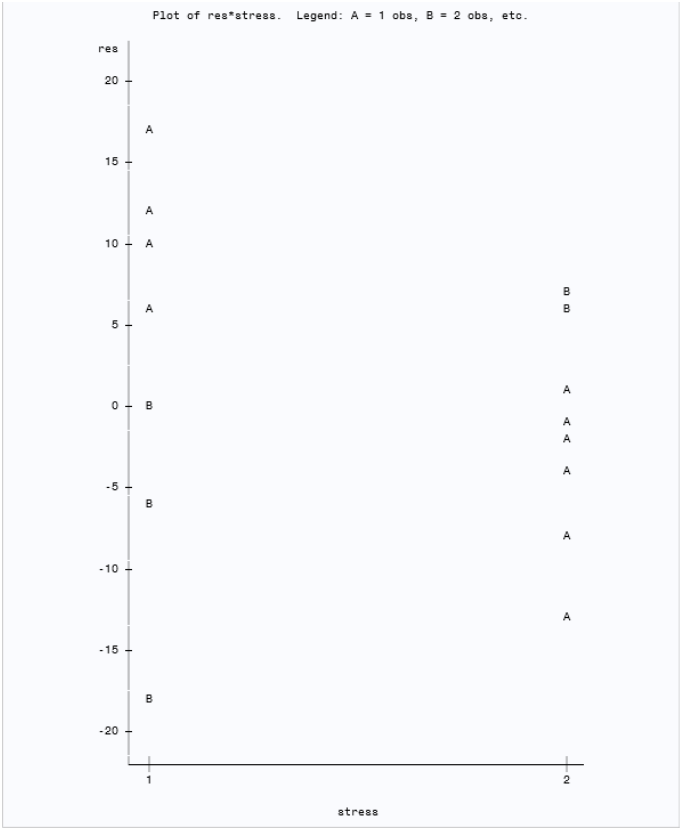
conclude that our normality assumption checks out.

Next, we check the equal variance assumption. First, notice that in the plot below of the residuals versus the predicted values that it appears that the variance decreases as scores increase.

Next, in the plot of the residuals of the scores for each nationality, that there is significantly more variance in the American students test scores than in those of the Korean Students.[11]



Similarly, in the plot of residuals versus the stress factor, we can see that there is significantly more variance in the scores of the students taking the timed exam versus those taking the untimed exam.[12]



One of the biggest reasons for these breaches in equal variance is that two students who happened to be American and

rresponds to American students

responds to the untimed exam.

both took the timed version of the exam received a score of one, whereas the other scores collected were all average or high. Still, however, we should be careful in accepting the results of my study due to the fact that not all basic assumptions were met here.

A discussion on problems and improvements

As discussed throughout the paper, There were significant problems with data collection. As such, I was unable to include more countries in my study. I was also unable to block for factors such as college major and gender, two major factors that may have affected my results. It would also be interesting to be able to look at levels of testing anxiety in both countries . In the future, I would love to be apart of a similar study backed by an entity who can provide the proper resources to run such a test properly.

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SAS Code

```
data Math_Test;
input nationality stress score @@;
datalines;
1 1 15 1 1 21 1 1 21 1 1 31 1 1 15
1 2 36 1 2 25 1 2 28 1 2 21 1 2 36
2 1 25 2 1 1 2 1 1 2 1 36 2 1 31
2 2 36 2 2 17 2 2 36 2 2 31 2 2 28
;
proc glm data = Math_Test;
class nationality stress;
model score = nationality stress
nationality*stress;
output out = mathnew r = res p = ypred;
means nationality stress;
means nationality/tukey cldiff;
means stress/tukey cldiff;

proc plot data = mathnew;
plot res*ypred;
plot res*nationality;
plot res*stress;
Run;

proc univariate data = mathnew normal plot;
```

```
var res;
run;

proc reg;
model score = nationality stress ;
run;
```