MIDDLE SCHOOL STUDENTS SCIENCE CURIOSITY ON BOTH SIDES OF THE EL PASO/JUAREZ BORDER

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by

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To my husband and family

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May 18, 2006 Manuela Ortiz

Abstract

The purpose of this study is to investigate middle school student interest in the Natural Sciences on both sides of the Mexican-American border, in El Paso and Ciudad Juarez. We used a structured survey consisting of 30 science curiosity items. Our sample consists of 685 middle school students from Juarez public schools and 585 middle school students from El Paso public schools. The students from Juarez are currently taking a physics class. The students from El Paso have not taken a course solely and specifically in physics. Our results show, as we hypothesized, that Mexican students have a greater science curiosity than the USA students. We found that Mexican students have a science curiosity level of 109.05 and for USA we obtained 98.37, according to an independent samples t-test, the differences between these values are statistical significant.

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Chapter 1

Introduction

1.1Population Analysis

The Hispanic population of the United States is growing rapidly, above the rate of the general population. According to the U.S. Census Bureau, from the almost 300 million people living in the United States, Hispanics constitute 14.1%, which translates to more than 41 million persons, a growth of 60% percent from 1990 (U.S. Census Bureau, 2000). Sixty-seven percent of these 41 million are of Mexican background. Of the remainder, 14% have Central and South American backgrounds, 9% are Puerto Rican, 4% are Cuban and 7% are of other Hispanic origins. There are three states with high percentages of Hispanic residents: New Mexico (NM), California (CA), and Texas (TX). The highest of any state is NM, where 43% of the population is Hispanic. California and Texas are next, at 34% each. Current statistics show that 46.4% of Hispanics in the United States have not graduated from high school and only 3% of Hispanic adults have a bachelor's degree, way below the national average of 9% (U.S. Census Bureau, 2000). These numbers show the necessity to improve this population group's education level. Eleven percent of the Hispanic population age 25 and over hold a bachelor's degree or higher (Day & Bauman, 2000). 24.4% of the U.S. population over the age of 25 have bachelors (U.S. Census Quickfacts).

In the United States, the number of Hispanic students that take physics classes is below the national average, and also low is the number of Hispanic students having science related

majors in college. The majors preferred by Hispanic students are business, social science and education. This is not different from the general population, which also prefers majoring in business and social sciences and shows little interest in science, technology, engineering, or mathematics (STEM) majors.

Why should we be alarmed by the levels of science interest in our students; not only Hispanic students, but in the general population? According to John People (1991):

> A country's economy is based on the technology it develops, and to develop technology it must be based on basic sciences. This is a compelling motivation to seek more enrollments on science majors especially in those that point to technological advancement, but how can it be possible if we can't make students take science classes on middle and high school. People also tell us that "in the U.S. the majority of students in a science major are foreign born, it can't be possible that the U.S. is the country that imports more minds and people to develop it's technologies, but that American should be the ones studying and developing science.

Returning to the high school level, across the nation the number of Hispanic students that take Physics or Chemistry classes is only 11%, which is disproportionate to the general population (Llagas & Snyder, 2003). In addition, data collected by the National Center for Education Statistics show that only (17.6 %) of Hispanic students choose to take optional science classes in high school. The proportion of Hispanic students taking these classes is below that of Non-Hispanic White students (25.7%) and African-American students (20.1%). This is a pattern that continues through college. We can only conclude that the public education system is failing to attract students to science, especially Hispanic students. This situation inevitably leads to difficulties for students if they reach college. If they choose a bachelor's program in engineering

or science, their poor science background will be against them, resulting in lower grades, frustration, and in many cases, the abandonment of this degree in favor of another that does not require such courses or in other cases the abandonment of college. The National Research Council (1999) reported that in both mathematics and science, U.S. seniors scored near the bottom compared to other nations (such as France, Canada, and United Kingdom).

What could be the result if all students were to take physic and chemistry classes in high school? Would be there a higher number of students and graduates on science majors? Would the success rate in college science classes be higher?

In Mexico, 23.6% of Mexican students are studying science in college compared to 17% of total U.S. bachelor-level degrees being in natural science (National Science Board, 2004). To create a frame of reference for the comparative investigation to be presented, I will now mention general differences between the educational systems of both Mexico and the United States and explore some general characteristics of each, specifically related to testing, curriculum and science course specifics.

Unlike the U.S., where the local school districts dictate the educational guidelines at the local or county level, Mexican schools across the nation, from kindergarten to High School are governed by a single entity, the Secretary of Public Education (Secretaria de Educacion Publica, SEP). Even though a certain amount of flexibility exists from state to state, it is merely to adapt to local idiosyncrasies and geographical characteristics. For example, a student from the northern industrialist state of Chihuahua learns the same subjects and reads the same textbooks as one from the mainly agricultural and indigenous southern state of Chiapas. However, a few lessons are different, reflecting the experiences of the different students (such as regional rituals and native traditions).

Since the subject matter, textbooks, tools and activities are shared by students of all public schools across Mexico, there is no perceived need to give standardized content tests when advancing from elementary to middle or from middle to high school. Every student is expected to retain the same basic set of knowledge in order to make advances in their education, whereas in the U.S. standardized tests (SAT or Iowa Basics) are used to compare students from across the county or state in a variety of content areas.

Mexican students are subjected to tests when moving from elementary to middle school, but these tests focused on the learning capabilities of students (such as verbal and mathematical response and abstract reasoning) and are used only as tools to enhance the learning experience of the student and not to measure their knowledge.

When moving from middle school to high school, Mexican students take another set of tests designed by the National Center for Evaluation (CENEVAL). These tests are designed to measure the same characteristics of the elementary-to-middle-school test but a section of mathematical, science and language knowledge is included in order to select the best students and to let them advance in their education. It is important to note that this discrimination is made because of a perpetual lack of space and facilities at the High School level and that it is an unofficial but widely practiced policy.

Another difference, and the most important for this study, is the approach to science education in each country. All American middle school students take a general science course each year. In Texas, high school students must take a minimum of two courses to graduate, an integrated physics and chemistry course and one in biology. More advanced courses are available in physics and chemistry, but they are not required. In Mexico, students in middle and high school have to take obligatory science classes each year. These courses include physics,

chemistry, and biology. By the time a Mexican student graduates from High School he/she has taken at least six years of continuous science, starting with introductory classes in the 7th grade and completing with advanced science classes in the 12th grade. These classes are not general or integrated science – they are discipline specific and at multiple levels.

The significantly higher number of students in science majors in Mexican universities and colleges (23.6% of Mexican students studying science) may be a result of this preparation. This number is higher than the proportion of American students, of whom only 17.1% study or graduate from a science major, despite the enormous advantage in economic and social conditions that American students have over their Mexican counterparts.

But are Mexican students more curious about science, more willing to study those subjects, or is it simply that they are better prepared because of six years of compulsory science education? Are the classes Mexican students take a medium for transmitting enthusiasm about science or do they only feed students knowledge? And, is preparation the reason for the higher number of Mexican STEM students or is it that they are more motivated to choose science as a career than American students?

To begin to answer these questions, this study will investigate the science curiosities of Mexican and American students on either side of the border.

El Paso Texas is located on the border with Mexico in West Texas and has an estimated population of 713,126 habitants, with the majority of them being Hispanics (U.S.. Census Bureau, 2000). The "racial makeup of the city was 73.28% White, 3.12% African American, 0.82% Native American, 1.12% Asian, 0.10% Pacific Islander, 18.15% from other races, and 3.40% from two or more races. 76.62% of the population was Hispanic or Latino of any race." Economically, "The median income for a household in the city was $32,124, and the median

income for a family was $35,432 . …The per capita income for the city was $14,388. 22.2% of the population and 19.0% of families were below the poverty line. 29.8% of those under the age of 18 and 17.7% of those 65 and older were living below the poverty line." (Wikimedia Foundation, Inc.)

The Hispanic population of El Paso follows the national educational levels mentioned earlier and therefore is predominantly has a weak educational background and low socio-economic level. For this reason it is common for these families to send their children to local public schools, being unable to afford a private education.

As the fastest growing minority in the U.S., it is important that Hispanics students leave high school with a good understanding of science and especially physics, with the ultimate goal that more Hispanics enter Science, Technology, Engineering, and Mathematics (STEM) major in collage.

1.2 Hypothesis

An expected result of this research is that the Science Curiosity level for Mexican middle school students' will be higher than that of American students. The reason for this prediction is the early contact Mexican students have with science classes, beginning in the seventh grade and continuing up to the twelfth grade. This allows Mexican students to be in constant contact with physics, encouraging them to see the world from a scientific point of view. With this educational, background Mexican students are better prepared than American students for college level science classes.

This also allows the students to complete with better results college level science courses. In contrast, American middle school students do not have a physics class experience, and are not familiar with this area of science..

1.3 Motivation

As George W. Bush, president of the United States said: “We need to encourage children to take more math and science and to make sure those courses are rigorous enough to compete with other nations.” This sentiment derives from the fact that each year, fewer students choose STEM majors on college and high school graduates go to college with a lesser understanding of math and science. Conclusions made by Misiti, Shrigley, Hanson (1991) indicate that it is at the middle school level that students develop their perceptions on science and math, influencing their class choices in high school and therefore also in college. Results from the Third International Mathematics and Science Study (TIMSS), performed by the National Center for Educational Statistics (NCES) of the Department of Education, indicate that U.S. education reform efforts need to focus particularly on improving students' math and science skills. In the next graphs we can see the distribution of students taking physics in high school by racial group.

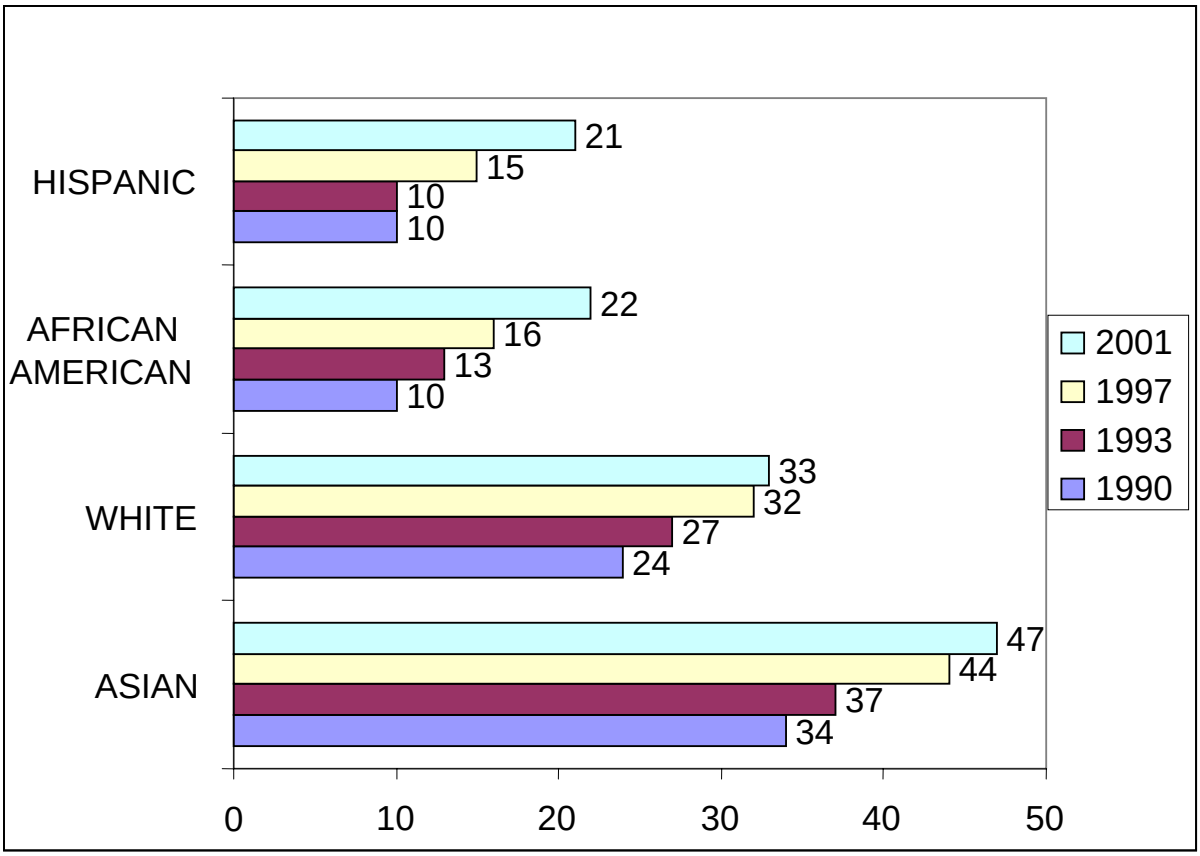

Figure 1.1 Percent of students taking physics class from different racial group. According to "AIP Statistical Research Center: 1989-93, 1996-97, and 2000-01 High School Physics Surveys"

Schools in the El Paso TX do not escape the national tendency of low attendance in science and math classes at the high school level. On the other side of the border, schools in Mexico, simlar to other countries, have obligatory science courses since the beginning of middle school. Being located on the border we have the opportunity to research the difference in science curiosity of students from Mexico, those that are taking obligatory discipline focused science courses, and students from our city, whom take general science.

Chapter 2

Background

2.1 Science Curiosity

The objective of this investigation is to measure and compare the level of science curiosity of middle school students from both sides of the American and Mexican border. This investigation will compare student perceptions from two different educational systems. The Mexican educational system includes formal and compulsory science classes including physics at the middle and high school levels. In contrast, the American educational system does not include obligatory formal physics classes, only general science classes at the middle school level and optional distinct physics and chemistry classes at the high school level. By studying the level of science curiosity of students from both countries we will know if taking formal science classes at an early age helps students to familiarize with science and increase their interest in it, while allowing them to take science classes at the college level with confidence.

What is science curiosity? According to Harty and Beall (1984), science curiosity could be interpreted as "a result of surprise, doubt, contradiction, cognitive conflict, complexity and novelty." Complementing this concept, Maw and Maw (1970) suggest that "an elementary school student shows his science curiosity when he a) has a positive reaction to new, strange, or mysterious elements in his environment; and b) exhibits a need or desire to know more about his environment" (p. 124). Since there have been no investigations of science curiosity at the middle school level, this investigation relies and follows guidelines made by the investigations made at

the high school level. Additionally, an exhaustive literature review has uncovered no more recent measures of science curiosity.

One of the references from these investigations comes from Halloun and Hestenes (1998). Results from the Views About Sciences Survey (VASS) suggest that "Students are disinterested in physics, they recognize the relevance of physics to the physical world, but not its utility in every day life." (p.572). As to the nature of classroom physics Redish, Saul, and Steinberg (1998), report "students view physics problems as simply mathematical problems, with equation and substitution of values."(p. 213). These studies suggest that at the high school level curiosity about science, particularly physics, has all but disappeared.

Setting this investigation apart from others is the choice of participants. While other investigations have focused on the physics perceptions and science curiosity of high school students, this investigation focus on middle school students, because of research suggesting that this is where American students lose interest in science. In addition, Misiti, Shrigley, Hanson (1991), state that "during the middle school years attitudes are formed that influence science course selections in the high school and college." Students at the high school level also "had lower interest in science than middle school levels" (Gibson, 1998, p.20) and various reasons for this has been suggested and analyzed, including the difference in teaching methods used on middle and high school (Gibson, 1998, p.20), lack of support from their parents (Bowen, Kenealy, 1985, p.345) and low levels of self-efficacy for science learning.

According to the American Institute of Physics Enrollments and Degrees Report (AIP, July 2002) and the data of all bachelor's degrees coming from the National Center for Education Statistics Digest of Education Statistics, 2002 (U.S. Department of Education, 2003) show how Physics Bachelors Degrees has been decreased compared to other Bachelors.

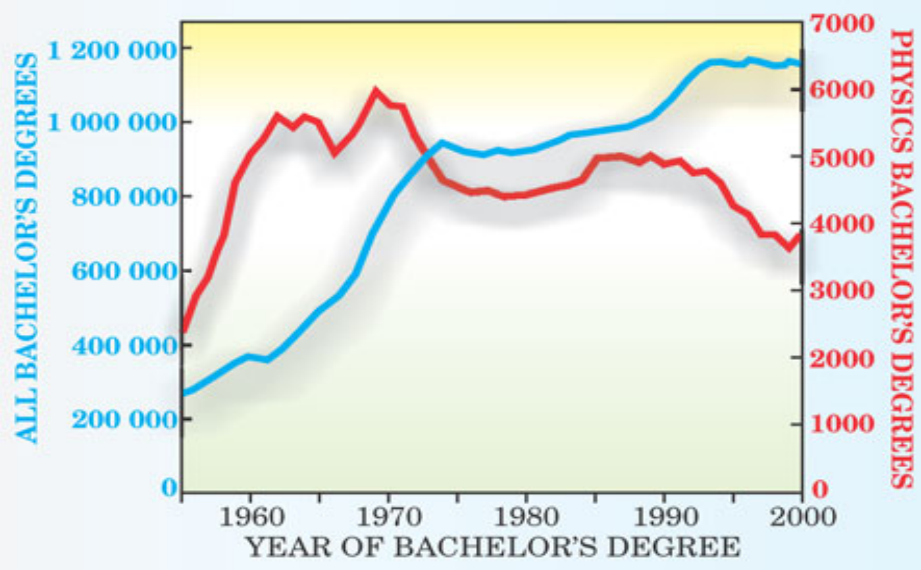

Figure 2.1 Comparison between the number of students doing physics bachelor's degrees and all bachelor's degrees.

Several studies had been made addressing the lack of motivation and curiosity of students toward science classes. Innovative programs that put students on direct contact with scientist (Gibson, 1994, p. 20) and (Sorge, Newsom, Hagerty, 2000, p. 339) and the real-life applications of science had shown that when having the opportunity, students show an increase on their attitude toward science (Gibson, 1994, p. 20) and (Sorge, Newsom, Hagerty, 2000, p.335). One of these programs is the subject study of Gibson from the Donahue institute, university of Massachusetts. The program is called Summer Science Exploration Program (SSEP) and was conducted on the Hampshire College of Amherst Massachusetts from 1992 through 1994. The program's goal was to stimulate and increase students' interest on choosing a science career since middle school. The students that participated in and completed the program showed a significant increase on their interest on choosing science as a career than those who did not participated.

We can see from the SSEP program results that the more students are involved and informed about the process of real life science their participation and interest on science classes will be greater. Another important fact from Gibson's research is the finding that students from middle school are more interested and has lees apprehension towards science classes than high school students. Gibson offers the explanation that middle school students are more interested because of the way their classes are taught. Middle school's science classes have a more hands-on approach than those of high school, which tend to be more lecture oriented. Middle school students interact first hand with science with diverse experiments and their teachers are more willing to offer an inquiry based class.

A similar program took place in University of New Mexico, and was the subject of investigation of C. Sorge, H. Newsom, and J. Hagerty. The conclusions of this research were much like those of Gibson, with the additional discovery that "Hispanic male students are more influenced by the nature of the teaching environment in learning science than an Anglo population" (MacCorquodale, 335), these finding comes to reinforce the line of thought that students respond positively to adequate stimuli by their teachers and the content of their science classes.

2.2 Previous Research

This investigation includes data from public schools across the border, in the Mexican city Ciudad Juarez. It was decided to include these data because international studies have proven useful for comparison. One of these researches was made in Germany. Stokking (2000), shows that the factors influencing whether students chose a science class are: "future relevance, perception, self-confidence and interest." (p. 1265). Another investigation, made by Reid and

Skryabina, (2002) focuses on the different perceptions of physics held by students of England and Scotland, two countries of the United Kingdom. The results are astounding, showing that "Scottish society considers physics as a useful, important, and relevant subject to future careers." (p. 67). In contrast, in England, physics is "Perceived as rather odd, only for very brainy."(p. 67). Students of two very similar countries, sharing language and government but different cultures having such different perceptions of physics, lead us to investigate further a cross border study.

Chapter 3

Process

3.1 Purpose

The purpose of this study is to compare middle school students' level of science curiosity, as measured with an updated version of Harty and Beall's *Children's Science Curiosity Measure,* on both sides of the Mexico-USA border, in El Paso and Ciudad Juarez. Since the intention of the study is to measure science curiosity at a certain age, we surveyed American students from seventh grade and Mexican students from the seven and eight grade. The average age of these students is fourteen years old.

The research was conducted in four schools total, two middle schools located in the United States and another two on Mexico. U.S. schools included El Dorado High School and Ysleta Middle School and the survey was administered to students from the six, seventh, eight and nine grade. Both of these schools were significantly appropriate for our study due to their student population characteristics. El Dorado HS, during the time frame of this study was transitioning into a 9^{th} through 12^{th} grade school. It began with 7^{th} through 9^{th} grade students and each year dropped a lower grade as students moved into a higher one.

El Dorado High School contains within its student population a majority of Hispanic students which accounts for the 91% of the student body and 30.2% of these students have a limited English proficiency. Also the majority of students, 71.5% come from a low socioeconomic status and poor parent's education background. El Dorado High School belongs to the Socorro Independent School District (SISD). SISD teaches 39,478 students younger than 18 years.

Our first sample consisted of 233 students from El Dorado HS, the majority of whom are attending the seventh and eight grades. Our second sample consisted of 354 students from Ysleta Middle School. Ysleta MS serves a population much similar to that of El Dorado, with 96% of its students being Hispanics and with the majority of students belonging to lower socioeconomic levels. Ysleta MS belongs to the Ysleta Independent School District, where a total population of 60,242 attends classes (NCES, 2006). Our total American sample consisted of these two groups, totaling 587 students on the American side of the border.

On the other side of the border student's backgrounds are similar to their American counterparts. In Mexico we also created samples from two middle schools, schools that belong to the federal education system, Escuela Secundaria Federal #1 (ESF #1) and Escuela Secundaria Federal #10 (ESF #10). Our first Mexican sample comes from ESF #1, which is the first middle school founded on Juarez and one of the fifth largest middle school in that city. The student population includes more than 1800 students divided in 7^{th}, 8^{th} and 9^{th} grade on two working shifts. From this school we extracted a sample of 470 students, 280 students from the 8^{th} grade and 190 from the 9^{th} grade which helped to maintain an average student age of fourteen years. ESF #10 serves to a lower-middle and middle-middle class population with medium socioeconomic levels and low educational background. Our second Mexican sample comes from ESF #10, which serves to a lower-middle and upper-low class, with low socioeconomic and educational backgrounds. 213 students from the 9^{th} grade were surveyed, again with a fourteen year average student age. The federal educational system in Mexico contemplates compulsory science classes that include physics, chemistry, biology and other natural sciences to all students starting at the 7^{th} grade. It is most important then, to mention that all students of our Mexican

sample had taken at least two years of formal science education and are currently taking three or more science classes.

This study will offer interpretations of findings that support adding obligatory and higher level elementary and middle school physics courses and will respond to this study's main question: Does obligatory Physics courses on middle school help to increase the science curiosity level on students?

3.2 Demographic Information

The next table shows general information about our sample; this information was collected by the answers students provided in the first section of the survey. Every student answered the questions of age, nationality and school personally; the gender was inferred from the student's name.

Table 3.1 Demographic Information of Participants (N=1270)

Characteristic	F	%
Age (years)		
11	1	.1
12	105	8.2
13	265	20.8
14	334	26.2
15	170	13.3
16	36	2.8
17	5	.4
Gender		
Female	633	49.6
Male	609	47.8
Missing	31	
Country		
USA	585	46.06
Mexico	685	53.93
Schools		
El Dorado	235	18.5
Ysleta	350	27.5
Federal #1	472	37.5
Federal #10	213	16.7

The average age of our subjects is 14 years and the distribution between genders is well balanced. It is important to note that even thought the distribution between countries is also balanced, it is not important to the effects of this investigation and a major difference in the number of participants from each country would not make a statistical impact.

3.3 Methodology

Our total sample consists of four independent groups. Each of these groups was assigned a code for practical purposes and to ease identification during the statistical analysis. Code assignment was as follows: The group composed by ninth grade students of ESF #1 it is called 1130, students from the same school but from eight grade are called 1120; the group composed of students from the ninth grade of ESF #10 is called 1230; the group of students from El Dorado HS is identified as 2100 and finally, the students forming the group from Ysleta MS are code named 2200. The code is constructed by the first digit indicating the country of origin (1 for Mexico and 2 for USA), the second digit indicates the school and the third and fourth digits distinct grade and group when necessary.

Table 3.2 Information about School Code

Country	School	Code	N
Mexican			
	Federal #1 3rd	1130	190
	Federal #10 3rd	1230	213
	Federal #1 2nd	1120	283
American			
	El Dorado	2100	235
	Ysleta	2200	250

This table shows the assigned code for each group and the number of individuals for each group.

From now on we will refer to each group and school by the code mentioned. This study will show a quantitative analysis of students' science curiosity. The medium of delivery of the survey will be paper and pencil.

To measure the students' science curiosity we used the "Children's Science Curiosity Scale" survey. We developed a quantitative statistical research. We are well aware that there are several factors that are relevant and could have effects ours results. Factor as education system, different cultures, environment, socioeconomic level, education background, etc. Such information is essential in a qualitative research, but in a quantitative research, as is ours, what is needed is hard numbers, in this case, the level of science curiosity. This type of research always invites to incredulity and certain controversy towards the veracity and validation of the method used to analyze the data. In order to avoid that situation this research used an already validated tool. This survey was developed and validated by Harty and Beall (1984) and it is composed of 30 Likert-type items with a scale of a minimum level of 30 and maximum level of 150. These items do not exceed 20 words and contains a Likert scale of: 5 (Strongly agree), 4 (Agree), 3(Uncertain), 2 (Disagree) and 1 (Strongly disagree). The Likert scale is used often on psychological and social science's research and it was decided to be an appropriate tool for this investigation, helping to analyze the data on the best manner and to calculate a produce a reliable result for the student's science curiosity levels.

3.4 Procedure

The first step in any investigation is to consider the ethical ramifications of the research. In order to address this step, the procedures and significance of the investigation were reviewed by the Institutional Review Board (IRB) at University of Texas at El Paso (UTEP). This assured the

researcher, the University and the participants that their rights as persons are protected. The ethical guidelines from the IRB are: the assignation of a number for each participant to protect their identity, the destruction of surveys after five years, and the assurance that there are no physical or psychological risks associated with taking the survey. After UTEP authorized the research, meetings with each school's principal were made. In those meetings the purpose and significance of the investigation was explained and the principals agreed to take part in the investigation, signing consent letters and arranging for the students' parents to receive consent forms. This procedure was carried out in both cities.

The next step was to translate the science curiosity survey into Spanish for the Juarez students. After the translation was done, it was administered to ten students from each city and feedback was asked and received. This helped to fine-tune the questions and eliminated any confusing phrasing. After the survey was modified, it was administered to the rest of the students on both sides of the border.

3.5 Data Collection

Students were surveyed in several stages on different dates. The first stage was completed in the fall of 2005, when students from El Dorado HS and ESF #1 were surveyed. Students from El Dorado took the survey during their science class from Dr. Hagedorn and Manuela Ortiz. The average time of completion for El Dorado students was twenty-five minutes. Their science teachers were not present during the survey. On the ESF #1 the survey was administered by Manuela Ortiz. Teachers from different classes donated their class time for the survey and they were also not present during the average twenty five minute period that the survey required. A

second stage of surveying was performed during the spring of 2006. Students from Ysleta MS and ESF #10 took the survey under similar circumstances of those students from the first stage.

On both stages students were instructed to answer in the most sincere way, they were told that the results of the survey in no way would affect their grades and that neither school officials nor teachers would know their personal answers.

Following the recollection of the answered surveys, every survey was verified and physically separated in groups corresponding to the codes mentioned earlier. The answers were typed on an Excel electronic spreadsheet and double checked before processing

For data process and analysis the software used was Statistical Package for Social Science (SPSS) v.11. After the data was imported from the Excel worksheet it was recoded. In this part of the process all the values from the negative items were reverted to obtain the correct data. Negative items on the survey were: item5, item6, item10, item15, item21, item25, item28, and item29. The directions to scoring the scale are illustrated below:

Table 3.3 Likert Scale for positive and negative items.

Items	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Positive Items	5 points	4	3	2	1
Negative Items	1 point	2	3	4	5

Using SPSS the descriptive statistics for each country for total curiosity (science curiosity scale sum) was calculated, the items calculated were the mean and standard deviation. The data were analyzed using the independent sample t-test. Gravetter and Wallnau, authors of book "Essential of Statistic for the Behavioral Science," suggest that independent sample t-test can be

applied only when only two independent samples are being compared. The t-test was used only to compare the student population from one country to the other. To compare the four samples against each other we made use of the Analysis of Variance (ANOVA) which is the best suited to “evaluate mean differences between two or more samples”(Gravetter & Wallnau, p.299).

Chapter 4

Overall Results

4.1Results

The Science Curiosity level was measured during Fall 2005 and Spring 2006 in two middle school from El Paso Texas and two school from Mexico. The total surveys administered were 1270, divided in four different middle schools and twenty one groups. Students were informed about the way the survey should be answered and the reason by we are interested in this type of statistical study.

4.2 t-test Results

To analyze the results of the survey, two statistics tools were used, the Independent Sample T-test and the Analysis of Variance (ANOVA). The t-test analysis helped us greatly on the first stage of the research; mainly to compare our two pilot samples' science curiosity means and therefore, to know if our hypothesis was correct or not.

The results from this preliminary test showed a mean (M) of 109.5 for Mexican students and a mean M=98.37 for American students. As the means from each group are fairly close, we had to know if this difference was significant from a statistical point of view. This is where the t-test is used. For the difference to be statistically significant the t-value calculated from the data had to be greater than or equal to the t-value obtained from the t distribution for 1268 degrees of freedom. The level of significance for this test had to be p=0.05 or less. The results obtained

from our data show that there is a statistical significant difference between these two means

Table 4.1

T value for Comparison of the Mean Curiosity Cores for Students Taking Obligatory Formal Physics Class (Juarez) and Students with General Science Class (El Paso)

Characteristic	M	SD	T	Df	Sig. (2-tailed)
City					
Juarez	109.05	24.1	8.66	1268	.000
El Paso	98.37	18.89			

In this initial stage of the research we were exploring several lines of thought and we decided to investigate if there was a significant difference in the curiosity levels of males and females, disregarding nationality and age. The t-test analysis showed that there is a significant difference between the science curiosity level of males and females of p=0.011.

Table 4.2 t-test Analysis. Groups Differences for Students Taking Obligatory Formal Physics Class and Students with General Science Class

Characteristic	M	SD	T	Df	Sig. (2-tailed)
Gender					
Female	105.90	25.31	-2.54	1237	.011
Male	102.65	19.23			

Seeing the interesting results from this analysis, we decided to analyze the differences between genders in each country. The t-tests showed that there is no significant difference

between males and females in the Mexican group with a coefficient of significance p=.450. In the American group, however, we do find a significant difference between males and females, with the females having a mean science curiosity measure of M=100.66 and males having a mean of M=96.03, giving us in the end a significance of .004.

Table 4.3 t-test Analysis. Groups Differences for Students Taking Obligatory Formal Physics Class and Students with General Science Class

Characteristic	M	SD	T	Df	Sig. (2-tailed)
Groups					
Mexican Female	108.72	17.03	-.757	683	.450
Mexican Male	107.74	16.93			
USA Female	100.66	17.68	-2.88	552	.004
USA Male	96.03	20.04			

To complete the analyses of our samples, we obtained the means and standard deviations of all groups. The next table shows a summary of this data.

Table 4.4 Mean Science Curiosity by Different Middle School Group (M=30 Min SC, M=150 Max. SC.)

Groups	M	SD	N
Students with a Formal Physics Class (Mexican)			
1130	112.8	35.17	190
1230	111.35	17.46	213
1120	104.76	17.98	282
Students with a General Science Class (American)			
2100	97.6	18.21	235
2200	98.89	19.34	350

The first group corresponds to the third grade of the ESF #1. This group obtained an average level of curiosity of 112.8. Close came the second Mexican group corresponding to the third grade of the ESF #10 with an average level of curiosity of 111.35; third comes the group of second grade from the ESF #1, with an average level of curiosity of 104.76. All these groups come from Mexican middle schools and take formal classes of Physics. Next on the table, the students from American middle schools that take optional classes of science. The first group, marked with the code 2100 comes from students of El Dorado High school and they obtained an average level of science curiosity of 97.6, the lowest level of all the groups. Second and last, the

students from Ysleta MS, which obtained an average curiosity, level of 98.89, still lower than the lowest Mexican group.

4.3 ANOVA Analysis

The limitation of the t-test, and a significant one for our investigation, is its inappropriateness for comparing more than two groups at a time. To overcome these difficulties, we used another tool, the Analysis of Variance test, or ANOVA, which allowed us to compare the five groups of our sample at the same time.

The following table shows the comparison between the different statistical factors concerning to our research, the square standard deviation (SS), degrees of freedom (df), mean square (MS), the F-ratio (F) and the significance coefficient (p). An F-ratio large enough to be significant at a level of 0.05 or less would indicate a significant difference in at least two of the five groups. An F value approaching 1.0 would show no significant differences between groups.

Table 4.5 Summary of Analysis of Variance (ANOVA).

Group	SS	Df	MS	F	Sig
Between Groups	37336.64	4	9334.16	29.601	.000
Within Groups	398896.5	1265	315.33		
Total	436233.1	1269			

The previous table, which compares between and within group variance only indicates the existance of a significant difference between at least two of the five group means. For this reason, we also included the Scheffe Post-Hoc Analysis, obtained through the SPSS program. This analysis containing comparison information between each and every group is shown below.

Table 4.6 Scheffe Post-Hoc Analysis Summary for Science Curiosity Comparison

(I) School	(J) School	Df	Mean Dif. (I-J)	Std. Error	Sig.
1120	1130	470	-5.48	1.66	.029
	1230	493	-6.73	1.61	.002
	2100	515	7.02	1.59	.001
	2200	630	5.72	1.42	.003
1130	1120	470	5.4	1.66	.029
	1230	401	-1.2	1.77	.974
	2100	423	12.50	1.73	.000
	2200	538	11.20	1.60	.000
1230	1120	493	6.73	1.61	.002
	1130	401	1.25	1.77	.974
	2100	446	13.75	1.67	.000
	2200	561	12.45	1.54	.000
2100	1120	515	-7.02	1.56	.001
	1130	423	-12.50	1.73	.000
	1230	446	-13.75	1.67	.000
	2200	583	-1.29	1.49	.945
2200	1120	630	-5.72	1.42	.003
	1130	538	-11.20	1.60	.000
	1230	561	-12.45	1.54	.000
	2100	538	1.29	1.49	.945

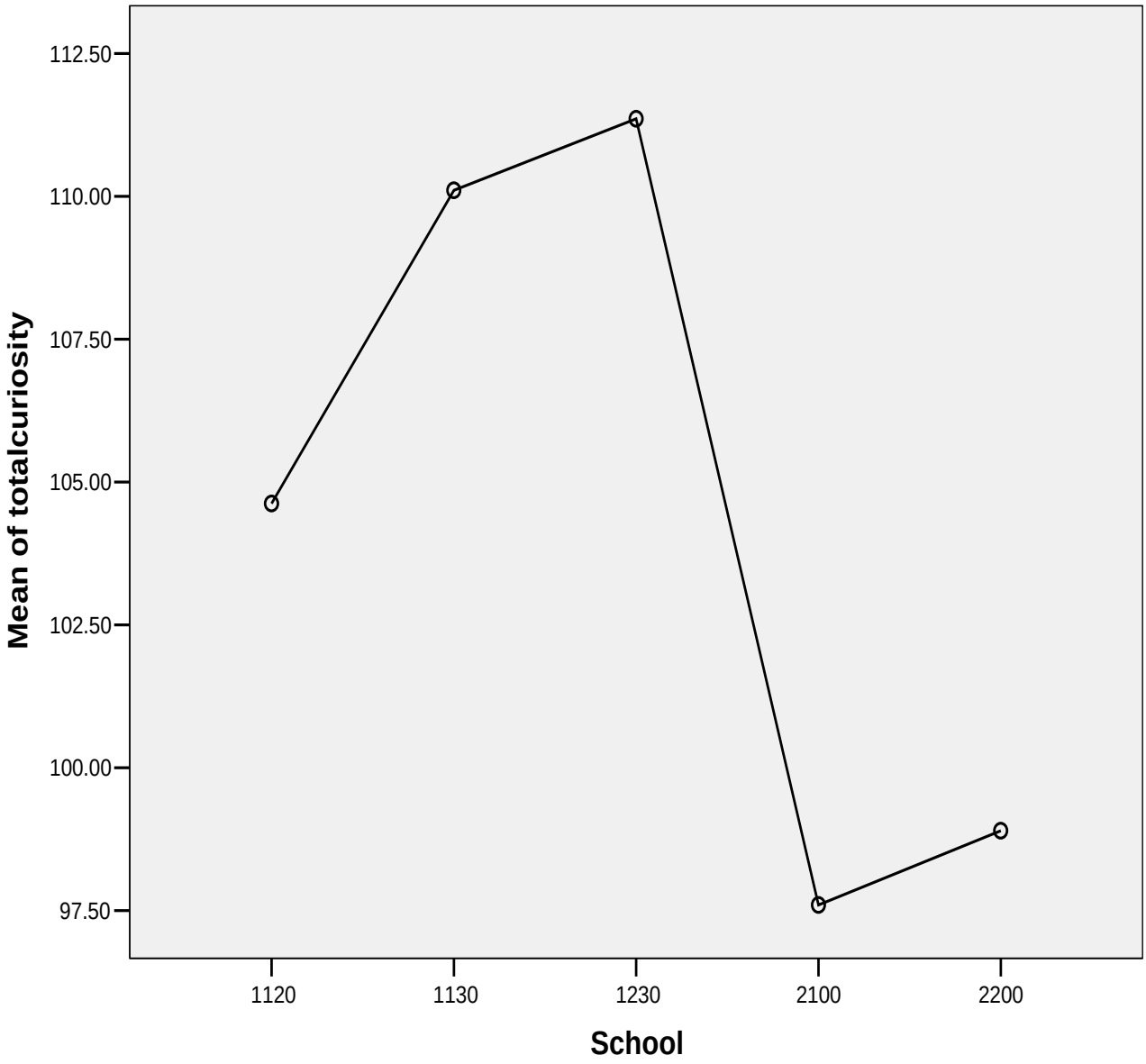

Figure 4.4 Means Graph of five groups from Juarez and El Paso

4.4 Summary Results

The results of our investigation indicate a clear difference between the science curiosity levels between middle school students from Juarez and El Paso. We found that the average curiosity level of students from the two Mexican schools included in the research is 109.5 points and the average curiosity from El Paso's middle school students is at 98.37 points. As mentioned

earlier, the thresholds of the curiosity level stand at 30 points minimum and 150 points maximum.

A comparison was made on the basis of gender, without regard to nationality. This demonstrated a higher curiosity level for females, who stand at 105.9 points, than males, who only had a curiosity level of 102.65. The t-test analysis tells us that this difference is statistically significant at the .011 level, indicating that such a difference was unlikely to have occurred by chance.

When we made the comparison between genders taking into account nationality, we found that American females are significantly more curious about science than American males. On the other side of the border the results demonstrate that there is no significant difference between the average science curiosity of Mexican males and females, with 108.72 and 107.74 points respectively.

Chapter 5

Conclusion

5.1 Speculation

The data presented in this paper and its analysis with statistics tools showed a clear result: Mexican middle school students from Juarez have higher curiosity level than their American counterparts in El Paso. We have several possible explanations for this. The main one is the fact that Mexican middle school students take three years of formal science education, allowing them to experience first hand physics, chemistry and biology. I believe that during these three years the students lose their fears and increase their enjoyment with and interest in science. They no longer see it as something mysterious and restricted only for the brightest, but they see that, yes science is difficult, but not impossible. They may discover that learning science can be slow and repetitive, but not boring; and better yet that science is an essential part of our lives and as such can be enjoyed greatly.

American middle schools students are not obligated to take more than general science courses. These courses are meant to teach the students science and perhaps instill a love for science in the students, but they seem to be failing. Several general courses amid the myriad classes that middle school students take are not enough to generate a genuine interest in science. Students themselves tend to create a myth that science is boring, difficult and reserved for the unusual or the nerd. With these misconceptions, students tend to avoid science classes, take the minimum required and learn very little of them.

5.2 Limitation of Study

Whenever we conduct an investigation dealing with people we are bound to find limitations and restraints. The reach of this investigation was somewhat limited, yet its results showed that we are on the right track and encourage us to continue. These results appear valid, but as we mentioned before, these results come from a limited sample that included only two schools from each country, in only two cities. A broader sample, including students from varying economic and educational levels and from more cities in both countries will give us a better understanding of the phenomena shown in this paper.

It is obvious that a student's attitude towards the survey is an important factor in their completion of the survey. It is possible that apathy, distractions and other external factors affected the answers made by students, but based upon our observations and interactions with the students during and after taking the surveys, we do not think that the results were affected in an important manner.

We are fairly certain that the American students' science curiosity is influenced by their misconceptions about science. With physics in particular, research cited in this paper indicates that these misconceptions include physics being difficult and impossible to understand without a strong mathematical background.

5.3 Future Work

We are well aware that any research involving humans, their thoughts and beliefs in this case, is very dependent on the attitudes of the participants, the preexisting conditions and the

environment in which the survey is administered. For this reason that we do not extrapolate our results onto the general population.

A great number of factors may have influenced the science curiosity of these students, factors ranging from the grades they obtained in previous science courses, the affinity of students for their teachers, the methods and practices their teachers employ, and students' attitudes towards science classes. Other factors, including the socioeconomic background of the students and teachers, parents' education level may also indirectly influence the attitudes of the students towards school in general and science in particular.

These are reasons for proposing further research on this subject. The current results are encouraging and point to a very interesting phenomenon that may have implications science education reform. A qualitative approach needs to be added to the quantitative procedures employed in this paper to further comprehend the relationship between physics classes and science curiosity in Mexico and from that data, generate information and recommendations for educational advisors on the national and local level. Focus groups or interviews of the American children could provide more insight into their lesser curiosity about science in general.

For future work on this subject, we plan to investigate additional variables that could be influencing students' responses and attitudes. With this and broader sampling we might be able to more broadly generalize our findings.

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Appendix A - PARENTAL CONSENT FORM FOR MINORS, English version

I authorize my child _____ to participate in the current research project for the Mathematics Science Partnership (MSP) which the National Science Foundation (NSF) has awarded to the University of Texas at El Paso (UTEP). I understand the purpose of this grant is to increase the quality and quantity of Science, Technology, Engineering, and Mathematics (STEM) teachers in El Paso County.

As a participant, my child may be asked to complete questionnaires and/or individual or group interviews that can be completed during the normal class period unless otherwise stated. Interactions may be audio or videotaped in order to preserve the quality of data collected. My child may be asked to complete pre and post tests. In addition, demographic information may be collected and linked to the questionnaires or interviews. My child will be assigned a code number in order to preserve his/her anonymity. All data will remain confidential. There will be no personally identifying information used in any paper or presentation resulting from this work. The obtained data will be kept in a locked room at UTEP, accessed only by members of the research team and destroyed when they are no longer needed for the purposes of the MSP grant or at the end of the grant at the latest.

There are no direct benefits to my child for participating, although the information my child provides may be used to review the MSP grant's activities, or to understand and/or improve teacher preparation at UTEP and the surrounding El Paso County. My child's participation is completely voluntary, and may be withdrawn at any time with no penalty or loss of benefit to my child. There are no apparent physical or psychological risks to my child that are associated with participation in the present study.

If I have any questions about the current study, I can contact Dr. Eric Hagedorn (915) 747 – 7540, Dr. Milijana Suskavcevic (915) 747 – 7549, or Dr. Sally Blake (915) 747-8983.

If I have any questions concerning my child's rights as a research participant, I can contact Ms. Karen Hoover, Institutional Coordinator for Research and Sponsored Projects at (915) 747 – 7939.

_____ _____

Signature of Parent/Guardian Date

_____

Research Director's Signature

Appendix B - PARENTAL CONSENT FORM FOR MINORS, Spanish version

FORMA DE CONSENTIMIENTO DE PADRES DE UN MENOR

Autorizo a mi hijo(a) _____ a participar en el proyecto de investigación para la Asociación de Matemáticas y Ciencia (Mathematics Science Partnership MSP) de la Fundación Nacional de Ciencia (Nacional Science Foundation NSF) que le fue otorgado a la Universidad de Texas en El Paso (UTEP). Entiendo que el propósito de los fondos otorgados a UTEP es para incrementar el número de maestros de ciencia, tecnología, ingeniería y matemáticas en el condado de El Paso.

Como participante, mi hijo(a) puede ser requerido(a) para completar cuestionarios y/o entrevistas individuales o en grupo, que serian completadas durante el horario normal de clase a menos que se haya dado previo aviso. Mi hijo(a) puede ser requerido(a) para tomar un pre-examen y un post-examen. Las entrevistas pueden ser grabadas en video o audio casete. Adicionalmente, se puede recabar información demográfica y ser relacionada a los cuestionarios o entrevistas. Se le asignara un código numérico a mi hijo(a) para mantener su identidad anónima y toda la información será confidencial. No se usara información personal de mi hijo(a) que lo(a) pueda identificar en alguna presentación o articulo publicado que resulte del proyecto de investigación. La información obtenida será mantenida en un lugar cerrado en UTEP y su acceso restringido al personal de investigación, y será destruida cuando ya no sea necesaria para propósitos de investigación o cuando los fondos asignados para la investigación se terminen, cualquiera que ocurra primero.

No hay beneficios directos para mi hijo(a) por participar, pero la información que mi hijo(a) provea puede ser usada para revisar las actividades en las cuales los fondos del MSP son usados, o para entender y/o mejorar la preparación de maestros en UTEP y las comunidades que rodean el condado de El Paso. La participación de mi hijo(a) es completamente voluntaria y en cualquier momento acabar sin ninguna penalización o perdida para mi hijo(a). No hay riesgos físicos o fisiológicos aparentes que estén asociados con la participación de mi hijo(a) en el proyecto de investigación.

Si tengo dudas o preguntas acerca del proyecto de investigación, me puedo comunicar con Sally Blake al teléfono (915) 747-8983 o con Eric Hagedorn (915) 747-7540 o con Mila Suskavcevic al teléfono (915) 747-7549.

Si tengo preguntas sobre mis derechos como participante del proyecto de investigación, puedo contactar a la Sra. Karen Hoover, coordinadora de proyectos de investigación, al teléfono (915) 747-7939.

_____ _____

Firma Fecha

_____

Firma de investigador

Appendix C – Science curiosity survey, English version

Name_____ Science Curiosity Survey

Please read the following statements and circle the choice that most truthfully tells how you feel about that statement.

1.	Science magazines and stories are interesting.	strongly disagree	disagree	uncertain	agree	strongly agree
2.	I like to watch television programs about science.	strongly disagree	disagree	uncertain	agree	strongly agree
3.	I enjoy collecting leaves or other things from the outdoors.	strongly disagree	disagree	uncertain	agree	strongly agree
4.	I like to watch magic shows.	strongly disagree	disagree	uncertain	agree	strongly agree
5.	It is boring to read about different kinds of animals.	strongly disagree	disagree	uncertain	agree	strongly agree
6.	I don't want to know how rainbows are formed.	strongly disagree	disagree	uncertain	agree	strongly agree
7.	I would like to listen to scientists talk about their jobs.	strongly disagree	disagree	uncertain	agree	strongly agree
8.	I want to know what causes wind.	strongly disagree	disagree	uncertain	agree	strongly agree
9.	I would like to experiment with the gadgets inside the space shuttle.	strongly disagree	disagree	uncertain	agree	strongly agree
10.	It is boring to visit with scientists in their labs.	strongly disagree	disagree	uncertain	agree	strongly agree
11.	It is fun to see inside of toys to learn how they work.	strongly disagree	disagree	uncertain	agree	strongly agree
12.	I like to talk about the planets and stars.	strongly disagree	disagree	uncertain	agree	strongly agree
13.	Movies and pictures about volcanoes are interesting.	strongly disagree	disagree	uncertain	agree	strongly agree
14.	I like to watch the sky and the stars at night.	strongly disagree	disagree	uncertain	agree	strongly agree
15.	I don't like to look at small objects through a magnifying glass.	strongly disagree	disagree	uncertain	agree	strongly agree
16.	It is fun to take walks and just look at plants and animals.	strongly disagree	disagree	uncertain	agree	strongly agree
17.	I like to grow plants.	strongly disagree	disagree	uncertain	agree	strongly agree
18.	I like to visit zoos to watch how animals act.	strongly disagree	disagree	uncertain	agree	strongly agree
19.	I like to watch the TV news reports about the space shuttle.	strongly disagree	disagree	uncertain	agree	strongly agree
20.	I would like to visit a museum to see dinosaur bones.	strongly disagree	disagree	uncertain	agree	strongly agree
21.	It is boring to hear other people tell about things astronauts have seen or done.	strongly disagree	disagree	uncertain	agree	strongly agree

22. I like to ask questions about how animals live.	strongly disagree	disagree	uncertain	agree	strongly agree
23. I like to measure things to see how big they are.	strongly disagree	disagree	uncertain	agree	strongly agree
24. I like to search for answers to questions about space travel.	strongly disagree	disagree	uncertain	agree	strongly agree
25. It is boring to learn new science words.	strongly disagree	disagree	uncertain	agree	strongly agree
26. I wonder what causes colorful sunsets.	strongly disagree	disagree	uncertain	agree	strongly agree
27. I like to watch clouds move across the sky.	strongly disagree	disagree	uncertain	agree	strongly agree
28. I don't like to do experiments with butterflies, even if it doesn't hurt them.	strongly disagree	disagree	uncertain	agree	strongly agree
29. It is boring to ask questions about how animals live.	strongly disagree	disagree	uncertain	agree	strongly agree
30. I like to touch different things to learn move about them.	strongly disagree	disagree	uncertain	agree	strongly agree

Appendix D – Science curiosity survey, Spanish version

Nombre_____ Curiosidad en Ciencia

Instrucciones: Lee cuidadosamente cada una de las siguientes sentencias y encierra la opción que mas se acerca a lo que sientes por ella.
Escala de curiosidad científica

1.- Las revistas e historias de ciencia son interesantes

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

2.- Me gusta ver programas científicos en la televisión

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

3.- Disfruto coleccionar hojas y otros objetos de la naturaleza

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

4.- Me gusta ver espectáculos de magia

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

5.- Es aburrido leer acerca de diferentes animales

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

6.- No quiero saber como se forman los arco iris

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

7.- Me gustaría escuchar a los científicos hablar de su trabajo

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

8.- Me gustaría saber que es lo que causa el viento

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

9.- Me gustaría experimentar con los aparatos del trasbordador espacial

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

10.- Es aburrido visitar a los científicos en su trabajo

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

11.- Es divertido desarmar los juguetes para saber como funcionan

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

12.- Me gusta hablar acerca de los planetas y las estrellas

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

13.- Las películas y fotografías de volcanes son interesantes

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

14.- Me gusta observar el cielo y las estrellas por la noche

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

15.- No me gusta observar objetos pequeños a través de una lupa

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

16.- Es divertido caminar y ver los animales y las plantas

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

17.- Me gusta cultivar plantas

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

18.- Me gusta visitar los zoológicos y ver como actúan los animales

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

19.- Me gusta ver los reportajes noticiosos del trasbordador espacial

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

20.- Me gustaría visitar un museo para ver esqueletos de dinosaurios

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

21.- Es aburrido escuchar a otras personas contar lo que los astronautas ven o hacen

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

22.- Me gusta hacer preguntas de la vida de los animales

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

23.- Me gusta medir cosas para saber que tan grandes son

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

24.- Me gusta buscar respuestas a preguntas de viajes espaciales

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

25.- Es aburrido aprender nuevas palabras de ciencia

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

26.- Me pregunto que causa los atardeceres coloridos

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

27.- Me gusta ver como se mueven las nubes a través del cielo

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

28.- No me gusta hacer experimentos inofensivos con las mariposas

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

29.- Es aburrido preguntar cosas de la vida de los animales

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo

30.- Me gusta tocar cosas diferentes para aprender más de ellas

Totalmente en desacuerdo No estoy de acuerdo No estoy seguro De acuerdo Totalmente de acuerdo