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Confirmation And Investigation Of Higher Science Curiosity In Juarez Middle School Students Compared To Their Peers In El Paso, Texas

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by

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ABSTRACT

In the last 20 years attitudes towards science and science classes in K-12 education have been an important topic of investigation due to the decreasing number of students choosing Science, Technology, Engineering and Math (STEM) related careers, and the increasing need for STEM prepared workers to cover the job demands of the future. The purpose of this study is to confirm a previously measured difference in scientific curiosity between middle school students in El Paso and in Ciudad Juarez, and to collect additional data that might tell us what the possible factors or reasons for this difference are. Our sample consists of 156 middle school students from Juarez public schools, and 448 middle school students from El Paso public middle schools. The Children's Science Curiosity Scale of Harty & Beall (1984) will be used to measure the curiosity level. Additionally, the students will be asked to respond to "Why do you like or dislike science?" Our results show that those obtained by Ortiz (2006) in a similar study persist but with a reduction of standard deviations. The percentage of students that state that they do not like science in Ciudad Juarez and El Paso are 9% and 14%, respectively. The most common reason to like science among students in Ciudad Juarez was related to the topics covered in class, and among students in El Paso was related to the experiments and hands-on activities done in class. After analyzing contingency tables with chi-squared tests and calculating the respective contingency coefficients, it is safe to say that even though relationships between the reasons to like or dislike science and country exist, these relationships are not strong. Other results, limitations, and future research also are discussed.

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CHAPTER 1: INTRODUCTION

The Beswick & Tallmadge definition of scientific curiosity given by Harty and Beall (1984) is an "individual's drive and readiness to seek out and resolve conceptual conflict." Scientific curiosity is one of the personal attributes that can lead to students choosing Science, Technology, Engineering, and Mathematics (STEM) related majors (Hofstein, A., Bez-Zvi, R., & Welch, W. W., 1981). Several studies have been made to measure this construct in children. One of these studies was conducted by Harty and Beall (1984), who developed an instrument to measure the scientific curiosity in children. With this tool, Ortiz (2006) found that middle school students in Juarez, Mexico have more scientific curiosity than middle school students at El Paso, Texas. This is a complex subject, and in early adolescence (6th-9th grades) there is still much to investigate.

My research is going to focus on finding a "Why?" to this difference between these middle school students. There are studies that demonstrate that Latino adolescents are less likely to select STEM-related majors than their non-Latino peers (Bouchey, & Harter, 2005; Navarro, Flores, & Worthington, 2007; Rosen, B., 1959). For example, Lent, Brown, Brenner, Chopra, Davis, Talleyrand, & Suthakaran (2001) used Social Cognitive Career Theory (SCCT) to study the relationship between the support and barriers perceived by the adolescents and their career goals. López, Ehly, and García-Vázquez (2002) made an exploratory study about the perceived supports and barriers, acculturation level, and the achievement of Mexican Americans in high school. Bouchey and Harter (2005) studied the perceptions of students about the importance their parents, teachers, and peers give to math and science and the students' performance in these subjects, as well as their intentions to select a STEM major. They also analyzed the difference in attitudes and career goals between Mexican American

and European American students, as a cultural phenomenon. Finally, Navarro, Flores, and Worthington (2007) test if SCCT can explain the results for Mexican Americans, taking into account their social-cultural background and their level of acculturation, in predicting the intentions and achievement of Mexican American middle school students in math and science.

1.1 Population Analysis

Statistics in Mexico (INEGI, 2010) show that among the population of individuals 15 years old and older, the average number of years in school a person has attained is 8.6 years. Among children from 6 to 14 years old, 94% go to school, but among adolescents from 15 to 19, only 57% attend middle school; and of the adults 20 years old and older, only 5% attend higher education. From the population 15 years old and older, 12.6% haven't complete the elementary education, 16% have only completed the 6 years of elementary school, 22.3 % have completed middle school (until 9th grade), 16.5% have graduated from high school and took at least one year of higher education (in this last percent is included the population that have a graduate studies).

According to the National Association of Universities and Institutions of Higher Education (ANUIES, by its acronym in Spanish) (2011), on average between the 2005-2006 and 2008-2009 school years, only 2.2 % of the students nation-wide, had science and math related majors, and 34.9% were enrolled in engineering or technology majors (STEM majors 37.1%).

According to data provided by the U. S. Census Bureau (2011), the average educational attainment of the population including all races 18 years old and older, is about 13 years, and for the Hispanic portion of the population that is 18 years old and older, it is 11 years. The Hispanic population represents 15% of the population in the U.S.. Statistics regarding enrollment in school indicate that 97.4% of the children from ages 5 to 15 years old go to

school. Among adolescents from 16 to 19 years old, 81.6 % are enrolled in school, and among adults 20 years old and older, 7.0 % are enrolled in a higher education institution. The numbers among the Hispanic population are: 96.6%, 73.7%, and 6.1%, respectively. Of the total population, 61.6% have graduated from high school and are not continuing with other studies, and 11.7% did not complete their schooling and are no longer in school. Among the Hispanic population, 40.4% have a high school diploma but are no longer enrolled in school and 27.3% have not received their high school diploma nor are enrolled in school.

My study will compare the science curiosity of middle school students in Ciudad Juarez against those in El Paso and determine if Ortiz' (2006) results persists. The U.S. Census Bureau reports that El Paso has a population mostly Hispanic, with only 13% of the population not Hispanic. For this reason we can state that the two populations have a similar cultural background. Data specific to the state of Chihuahua, where Ciudad Juarez is located, indicate that the average number of years in school a person has attained is 8.8 years, 4.2% have no schooling, 58.1% have completed elementary education, 1.3% have a technical career and have completed the elementary school, 19.6% completed high school, and 16% completed any level of higher education. According to ANUIES (2011) on average, between the 2005-2006 and 2008-2009 school years, for the state of Chihuahua, the percentages of students enrolled in a STEM major are 1.0% for sciences and math and 40.1 % for engineering and technology. ANUIES also reports that out of the total students in graduate school, 16.3% were in a STEM related field.

1.2 Elementary education schemes.

The school system in Ciudad Juarez is divided into three major sections. Years 1 to 6 from the "primaria" level, at the end of which the children earn a certificate and change to the "secundaria" level. This level is equivalent to the 7^{th} through 9^{th} grades, also at the end of

which the students receive a certificate and change to the “preparatoria” or “bachillerato” level. This level is not mandatory, but it is necessary to have the “preparatoria” certificate if the students want to pursue any kind of higher education. The “preparatoria” is equivalent to the 10^{th} through 12^{th} grades.

The schools in El Paso have a similar scheme, elementary school goes from the 1^{st} to 5^{th} grades, middle school from 6^{th} through 8^{th} grades and high school is from the 9^{th} through 12^{th} grades.

One of the differences between the two educational systems is that the students in El Paso’s schools only get a diploma when they finish high school. Another important difference is that science in Ciudad Juarez is compulsory and is divided into Chemistry, Physics and Biology classes of increasing difficulty. They begin in the 7^{th} grade (“secundaria” 1^{st} grade) and increase in difficulty level until the end of 12^{th} grade (“preparatoria” 3rd grade). In El Paso science classes are recommended, but their content is more general and less math based.

1.3 Research Questions

Ortiz (2006) found out that the difference in mean scores of a sample of middle school students in El Paso (n=585) and Juarez (n=685) on an instrument that measures scientific curiosity (Harty & Beall, 1984) is statistically significant, and is greater in Juarez. This prompts the questions: Does these results persist? Why are middle school students in Juarez more scientifically curious than the students in El Paso? Is this due to the early exposure of Mexican students to more theoretical and compulsory classes? Or is there something else? Is the cause of this difference something inside the school or in the home?

1.4 Motivation

Both the United State’s and Mexico’s economic futures require that citizens of these two countries have a basic grasp of science, as well as some of their citizens becoming experts in

science. We are studying what makes science interesting or not interesting to students because this is so important for future economic development. Because many El Paso students come from Ciudad Juarez, understanding and comparing interest levels can better inform our local El Paso school districts.

This research may help us to understand what motivates students to study science, which can be very beneficial to them. It is important for society to know more about generating citizens willing to become experts in science, and for future economic development to know better how to achieve more of the population having a basic grasp of science. If we can know what motivates these students to be interested in science, then we can develop new programs and approaches to make gaining more knowledge in science more desirable.

CHAPTER 2: LITERATURE REVIEW

Osborne, Simon, & Collins (2003) wrote a helpful literature review about attitudes towards science. In the last 20 years, and perhaps more so today, these attitudes have been an important topic to investigate due to the decreasing number of students choosing STEM related careers, and the increasing need for STEM prepared workers to cover the job demands of the future: ". . . the increasing dependence of contemporary life on sophisticated artifacts makes us communally dependent on individuals with a high level of scientific and technological expertise and competence" (2003, p. 1052) Various studies have found that it is prior to and during adolescence when these feelings towards science are defined. In the 1970's some investigators found that attitudes towards science were influenced by the difficulties students face in such subjects. Nowadays it seems to be more the lack of intellectual challenge and the sense of science being boring that makes students withdraw from it.

For measuring attitudes towards school science Osborne, Simon, and Collins summarized 5 different ways to gather data: (a) subject preference studies, where the researcher asks pupils to rank their liking of school subjects; (b) attitude scales; (c) interest inventories; (d) subject class enrollment patterns; and (e) qualitative studies.

Attitude scales are the most common approach, even when it is the most difficult approach for insuring accuracy and meaningful statistical significance for measured changes. Gardner (1995) points out that it is important for a scale to measure a continuum and give significant information about the subject it attempts to measure. The scale must also be unidimensional and internally consistent. Interest inventories list a variety of subjects in which students may be interested and solicit either ranking or checkmarks. These inventories are more restrictive in their focus, but tend to be more reliable than attitude scales. Which classes

students enroll in can provide some insight into their attitudes towards science, but many factors other than individual personal choice play into which classes a student takes in school. Finally, qualitative approaches provide context and insights that quantitative methods cannot, but by their very nature, these insights are not generalizable.

From findings in the two decades preceding their study, using each of these methods, Osborne, Simon, and Collins point out, that even though there are gender differences among 11 year old to 13 year old students, “in most countries, the evidence would suggest that children enter secondary school/junior high with a highly favorable attitude towards science and interest in science, both of which are eroded by their experience of school science” (2003, p. 1060). This brings up the important difference between attitudes towards school science and towards science in general, being mostly positive towards the latter.

Of factors influencing students’ attitudes towards science, research has identified gender as an important internal factor, with girls being less interested in science. Of environmental factors, Osborne, Simon, and Collins have identified the four most mentioned: (a) structural variables, such as socio-economic level, parental support, peers and friends attitudes towards science, etc.; (b) classroom and teacher factors; (c) curriculum variables; and (d) perceived difficulty of science.

High level of involvement in classroom activities has been associated with positive attitudes towards the class, and good teacher’s communications skills with a better attitude toward science. Simply put, the quality of the teaching affects the attitude of the students’ choice to study science. According to the reviewed research, curriculum variables have less influence on the attitude of students towards science than teachers’ communication skills and the classroom involvement.

A recommendation from some studies is that the vocational counselors should focus their verbal remarks on the lost of opportunities that a student can have if they do not pursue STEM related subjects instead of remarking how valuable studying science can be.

Another concern, emphasized by American researchers, is the relationship between ethnic origin and attitudes toward science and careers in science. Greenfield (1995) found that this influence was more significant than gender, with Caucasians having the more positive attitudes. Lemke (2001) noted that the process of engagement in science could not be the same for every social class and cultural background, and that those factors must be taken in account when planning programs to boost interest in science.

In conclusion, Osborne, Simon, and Collins, observed that all these studies have carefully identified the problem, but not how it can be "definitively" solved. Some suggested that if the students have more sense of control, their level of engagement would be boosted. Changes in curricula are also proposed, but according to the authors, this is a long term solution. In the short term, they suggest the improvement of the classroom environment, specifically to help enhance science "task value" for students.

This study, as well as Ortiz (2006), focus on a particular science attitude, science curiosity. To better understand this internal attitude and its measurement, we need to look at research going back to the 1970's.

In the early 70's there was much discussion about the relative roles of "cognitive" and the "affective" aspects of teaching science and their influence on the arousal of scientific curiosity in young students. The studies to be presented now show the evolution of thought that leads to the instrument used in this thesis.

In 1971, James Reed Campbell investigated how junior high school (7^{th} and 8^{th} grade) science teachers interacted with their students and how this impacted both their students'

learning and attitudes towards science (Campbell, 1971). A complex observational rubric was used to generate a quantitative measure of the ratio of a teacher's "indirect" interactions with students to their "direct" interactions. Indirect interactions were defined as ones where the teacher accepted the students' feelings and ideas, or praised them. The direct interactions were those where the teacher concretely directed or criticized the students. To measure the relationship between this indirect to direct ratio to attitude, Campbell made use of several attitudinal measures. The most important to this thesis research is his "Scientific Curiosity Inventory."

Campbell devised this measure of attitude – although he referred to attitudes as "affective outcomes" – based upon three levels of the affective domain of Bloom's Taxonomy (Krathwohl, Bloom, & Masia, 1964): (a) receiving, (b) responding and (c) valuing. These levels are hierarchical, with receiving being the lowest level and valuing the highest. Each level was probed with 18 items. An example of a "receiving" prompt is: "Have you ever wondered why objects falling from high above the ground move faster as they fall?" A "responding" prompt is: "I would join a science club to answer my curiosity about such questions." A "valuing" prompt is: "To know the why's, what's, and how's about such science questions is important to me." Responses of yes or no to each series of 18 prompts leads to a subscale score for each of the three levels. The higher the percentage of yes responses, the higher the subscale score. To summarize the results of Campbell's investigation: he found that the students of teachers who had more indirect interactions with them, had higher values of scientific curiosity afterwards.

One study in 1979 is particularly relevant to this thesis: Pinchas Tamir's "Scientific Curiosity and Inquiry." In the first place, it presents a cross-national comparison of scientific curiosity (Israel and the U.S.) and in the second, it makes use of Campbell's inventory. Tamir measured scientific curiosity among high school students (10th -12th grades) and related this

measurement to a measure of the level of inquiry achieved in teaching biology. To measure the inquiry level, Tamir created prompts which solicited responses in three categories: "inquiry oriented", "anti-inquiry" and "neutral". The responses of the students to these questions in reference to one teacher, generate a mean inquiry score indicating just how "inquiry oriented" or "anti- inquiry" this particular teacher is.

The Israeli participants were 226 high school students from 11 different schools, that represents both city and kibbutz schools. Each participating school had a different biology teacher. The results from Campbell's inventory had an internal consistency reliability of 0.90. The inquiry questionnaire had three subscales (with their Cronbach reliability coefficients in parentheses): receiving (0.77), responding (0.83) and valuing (.81).

After analyzing the results from the questionnaires, Tamir found that the number of students with more "yes" responses declines from receiving to responding to valuing. There were no differences between males and females. The relationship between scientific curiosity and the inquiry level of teaching biology was positive, but weak. In other words, the more inquiry-based the students perceived the biology teaching, the higher their scientific curiosity. The author commented: "A more inquiry oriented instruction will result in a higher level of students' involvement which raises their scientific curiosity" (1979, p.429).

Very interestingly, it was also found that the Israeli students had higher levels of scientific curiosity than their peers in the U.S. Tamir explained this in terms of science teaching/learning in the United States being more passive (less inquiry) and thus promoting less curiosity. We do need to take caution in making inferences based upon these results because the study is old, and the curricula may have changed. Nevertheless, this is an example of a lower scientific curiosity in students in the United State's as compared to another country.

Until 1984 there were a few empirical studies about the scientific curiosity of children, specifically, elementary school students. You will remember that Campbell's (1971) study focused on 7^{th} and 8^{th} grade students, and Tamir's (1979) study focused on high school students. This was an oversight as it has been put forward that scientific curiosity is a major factor influencing the decision of young people to study science.

One of the reasons for this lack of studies, Harty & Beall argue (1984), is that there was no valid instrument to measure this construct for children in elementary school. Harty & Beall review several efforts to measure curiosity: (a) Penny and McCann's (1964) "Children's Reactive Curiosity scale", (b) Maw and Maw's (1968) "About Myself Rating Instrument of Curiosity", and (c) Campbell's (1971) "Scientific Curiosity Inventory". Penny & McCann's instrument consists of 90 true-false items. Maw and Maw's instrument consists of 40 true false items referring to a story read to the students. Campbell's inventory consists of 54 yes-no items.

To develop a reliable and simplified instrument to measure the scientific curiosity of children, Harty & Beall (1984) drew upon items from different scales, but mostly from Penny and McCanns's general instrument. They did so by translating items into a science learning context and a 5-point Likert, rather than true/false, response format. Their efforts took into account the reading levels of upper elementary school students and the attention span of students of this age. Their first version instrument had 71 items.

Harty & Beall used a variety of reliability and validity analyses to select the 30 items that best measure their construct of science curiosity. Their first validity analysis (face validity) involved having two additional professors and four elementary school teachers carefully read and screen items for relevance and readability. This led to the elimination of fourteen items. The remaining 57 items were then given to a panel of 8 expert-judges who eliminated items or

made suggestions for rewording. This type of review contributes to content validity. It led to an instrument of 48 items.

At this point, Harty & Beall used reliability, the consistency of the instrument to produce the same results under the same circumstances, to eliminate items. A commonly used measure of internal consistency is called the Cronbach alpha coefficient. It varies between 0 (poor reliability) and 1.00 (perfect reliability). A value of at least 0.80 is considered acceptable. A key quantitative factor determining alpha reliability of the whole instrument is how well individual item responses correlate with the combined scores of all the other items. This value is known as the item-total correlation and best practice suggests eliminating or rewording items with values of less than 0.30. This procedure reduced the number of items from 48 to 36. An additional reliability analysis eliminated three items and led to the rewriting of one for a total of 33 items.

The final 3 items were eliminated through a concurrent validity procedure. Concurrent validity refers to how well scores from one instrument agree with scores from another valid and reliable measure. To assess concurrent validity, Harty & Beall asked 95 fifth graders to report whether they were really interested in science or not. They were then given the 33 item instrument. Three items did not well predict into which group the students had self-indicated (really interested group or not interested). Those three items were eliminated to produce the published 30 item version of the instrument known as the "Children's Science Curiosity Measure" or "CSCM." This instrument was used in Ortiz' (2006) study and this thesis. It has been used in more recent studies, such as Sharp and Kuerbis' 2005 study of children's ideas about the solar system. (Sharp, J. G., & Kuerbis, P. (2005). Children's ideas about the solar system and the chaos in learning science. Science Education, 90(1), 124-147.) The scores on

the CSCM range from 30 (for a student choosing all 1's or strongly disagrees) to 150 (for a student choosing all 5's or strongly agrees).

Manuela Ortiz, in her thesis: "A Comparison Study of Science Curiosity of Mexico and U.S. Middle School Students" conducted a comparative cross-national study of scientific curiosity as measured with the CSCM. The propose of the study was to compare the scientific curiosity level of middle school students in Ciudad Juarez with that of middle school students in El Paso. The purpose of Ortiz' study was to investigate why each year fewer students are taking STEM related majors. Being on the border required investigating two different school systems: the Mexican system with compulsory classes for middle school students in the distinct areas of science (physics, chemistry, biology); and the American system with more general science classes required for middle school students.

The data for this study were collected from middle school students using the CSCM, which were completed during science classes without the science teacher being present. The participants for this study were middle school students: 485 from the El Paso area and 686 from Ciudad Juarez schools. With an average age of 14 years, the participants attended grades 7 through 9th. The selected schools in El Paso have a Hispanic majority population. The social economic background level of the students from both cities is on average the same. The sample of students selected can be labeled a clustered convenience sample: selected from schools in the two countries whose principals were willing to work with the investigator.

To compare the samples from both cities, Ortiz used an independent samples t-test on the mean CSCM scores. Analysis of variance (ANOVA) was used to compare the mean science curiosity of each school against the others. The mean raw score for U.S. students was 98.4 (SD = 18.9). The mean raw score for the Mexican students was 109.1 (SD = 24.1). The t-value for difference in these means is 8.67 ($df = 1268$, $p < 0.001$).

Ortiz' study focuses only on measured scientific curiosity. It is interesting see that the difference between the schools in Ciudad Juarez in comparison with those in El Paso is greater not only as an average across both cities but that each group in Juarez compared with each of the schools in El Paso is greater on average. The main curricular difference between the students in each city, is that the students in Ciudad Juarez had already take one or two years of specific science courses: biology, chemistry, or physics. The students in schools in El Paso had only taken general science courses: life science or physical science. Perhaps this difference in curriculum leads to the difference in curiosity. Could this be the cause of the difference? Could the difference be explained by Tamir's statement in the early 70's that a more inquiry kind of instruction (Mexico) will lead to a higher scientific curiosity? Ortiz' study does not explore the cause for this difference. This thesis research does.

CHAPTER 3: METODOLOGY

3.1 PURPOSE

The purpose of this study is to confirm the difference in scientific curiosity between middle school student in El Paso and in Ciudad Juarez, and collect data that can tell us what are the possible factors or reasons for this difference. Since the intention of this research is to confirm the difference in curiosity levels found by Ortiz (2006), we surveyed middle school students of about the same ages and in Ciudad Juarez area, we surveyed the same schools. On both sides of the Mexico-USA border we surveyed students from the seventh and eighth grades. The average age in general was 12.23 years old. The Ciudad Juarez students had an average age of 13.1 years old and the El Paso students had an average age of 11.85 years old.

This research was conducted in four schools altogether, two middle schools located in El Paso and another two in Ciudad Juarez. The two schools in El Paso belong to a large urban El Paso school district, and the data collected was part of a large externally funded evaluation project for the district. The two schools in Ciudad Juarez were the same schools in which Ortiz conducted her research. The Escuela Secundaria Federal #1 (ESF1) located in the Ciudad Juarez downtown area is one of the first middle schools in Ciudad Juarez. The Escuela Secundaria Federal #10 (ESF10) located in the southern part of the city and serves a low income community.

This study will attempt to confirm the difference in scientific curiosity as measured with the Children's Scientific Curiosity Instrument, between students in Ciudad Juarez and El Paso. If confirmed, the next part of the research, will be to begin to find out why. To do so answers to the open-ended question: "Why you like or dislike science?" will be collected. These

answers will be categorized and compared for each city to explore any relationship between liking science and measured scientific curiosity.

3.2 METHODOLOGY

Our total sample consists of two independent and principal groups, (a) students in the Mexican schools and (b) students in the American schools. These groups will be divided in two groups according to their answer to the question of whether they like (1) or dislike (0) science.

To measure the level of scientific curiosity we will use the “Children’s Science Curiosity Scale” survey with the initial open ended question: “Why do you like or dislike science?” added. The medium of response for the survey will be paper and pencil. The medium of delivery of the survey will be myself/the classroom teacher. This survey to measure the scientific curiosity construct is the same one that Ortiz used for her research and which has ample evidence of validity and reliability. The quantitative data and the qualitative data will be examined and interpreted as follows.

First, all statements will be copied to an electronic spread sheet. A set of categories will be created. Each statement will be assign a number according to the category into which it fits. To validate the categorizing, the same statements and categories will be sent to several physics and math teachers, with different educational levels, bachelors, masters and a doctoral degrees, to make their own selection of category for each statement. These selections will be compared and the category that is chosen the most will be selected. Once each statement is categorized the frequency counts and percentage of responses will be made, by country. Chi-squared tests and the related contingency coefficients, will be calculated to determine the relationship, if any, between the categories of response and nationality. In addition, the two most selected categories, positive and negative, will be compared against each other and by

country, using chi-squared tests and contingency coefficients to determine the presence and strength of any relationships.

3.3 Procedure

To begin our research, Human Subjects approval from the Institutional Review Board (IRB) at University of Texas at El Paso (UTEP) was obtained. Because our surveys were administrated in the U.S. as a part of another study that already had Human Subjects approval, and the school district provided a letter indicating that they agreed to share this information with us, and granted us the permission for it to be used for our investigation. We were also granted permission to publish any results that came from these data provided we did not use the names of the district, the schools, or the children.

Following the IRB approval, we sought and received approval from the principals in the Mexican schools to distribute the surveys to their students in the grades they selected. Through these procedures the safety and the well being of the participants were guaranteed. As part of our IRB protocol the written permission of the parents or guardians was obtained before the surveys were handed to those students. In the classrooms the nature of the research was explained to the students and a written assent form was obtained from them just before they answered our question and completed the survey. The survey in its English version was administrated to the El Paso Schools and the Spanish version of it was given to the students in the Ciudad Juarez area. This Spanish version was validated in Ortiz' study (2006).

3.4 Data Collection and Preparation

The Mexican students were surveyed during the spring period of 2012, in both schools a week before their spring break. The American students were surveyed in May 2012.

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

Once the surveys were collected from the students their answers were typed into an electronic spread sheet and processed. The quantitative data and the demographic information provided by the students were arranged in a first file. A total science curiosity score will be generated by summing the responses to each of the 30 items on the CSCS. Eight of the CSCS items are negatively worded. The responses to these items will be recoded before being summed. The recoding will replace "1" with "5", "2" with "4" and vice versa. "3" will remain the same.

The responses to the open-ended question were also typed into a second electronic spread sheet. These answers were divided into two parts based upon the assigned number for whether they liked or disliked science. Responses such as "I like science" or "I like science class" were labeled with a "1". Phrases such as "I dislike science" or "I don't like science" (0).

3.5 Data Analyses

Descriptive statistics for the CSCS results, means and standard deviations, will be calculated using the Statistical Package for Social Science (SPSS) v.11.5.0, for each of the two national groups. These data will also be tested for normality. If the data are normally distributed, the mean science curiosity score for the U.S. will be compared to the mean score from Mexico using the independent samples t-test. If the data differ significantly from the normal distribution, they U.S. and Mexican means will be compared using the Mann-Whitney test (Siegel, 1956). For any significant difference, a Cohen's effect-size *d* will be calculated (Cohen, 1992). The equations for this are:

$$d = \frac{\bar{x}_1 - \bar{x}_2}{s},$$

$$s = \sqrt{\frac{(n_1 - 1)SD_1^2 + (n_2 - 1)SD_2^2}{n_1 + n_2 - 2}}$$

Where *n* is the number of subjects in each group, and *SD* is the standard deviation of each group, while $\bar{x}$ is the mean of each group. Effect sizes provide insight into "how big" or "meaningful" a difference in means actually is.

All the answers to the open-ended questions, explaining why the students like or dislike science will be categorized and displayed using frequency polygons. The responses will also be cross tabulated for the analysis and interpretation of the percentages differences in the various categories and in terms of the "like" or "dislike" science categories. For these analyses Chi square values (Siegel & Castellan, 1988) and contingency coefficients (Fraenkel & Wallen, 2009) will be calculated. This coefficient will be interpreted according to the guidelines in Volker (2006).

CHAPTER 4: RESULTS

Of the 260 consents forms sent to parents and guardians of students in the Mexican schools in our study, 156 consents were granted, and that was the number of surveys given to the students. In El Paso, 448 completed surveys were provided to me by the district. A number of surveys have missing cases in different variables that we are observing. For example, for the science curiosity items there are 34 item responses missing from the Mexican cases and 43 from the American cases. All the age responses were completed in the Mexican surveys, but 83 American students did not state their age. In the case of gender there were 16 missing cases, all from the American data. From the open-ended question posed to the students, 21 students from the Mexican schools did not answer the question nor did 53 from the American schools.

All the survey data was used in the different analyses because not all missing items are in the same survey. Missing items will be reported with the results of the analysis of the variables. These missing items happened in no more 15% of the cases.

4.1 DEMOGRAPHIC INFORMATION

From the 604 surveys collected, only 521 responded to the age question in the survey. The mean ages (with standard deviations in parentheses) for Mexican and American students were 13.10 (0.772) and 11.84 (0.700) respectively. The median for the available sample (*n*= 521) is 12 years old. (See figure 4.1 for the age distribution).

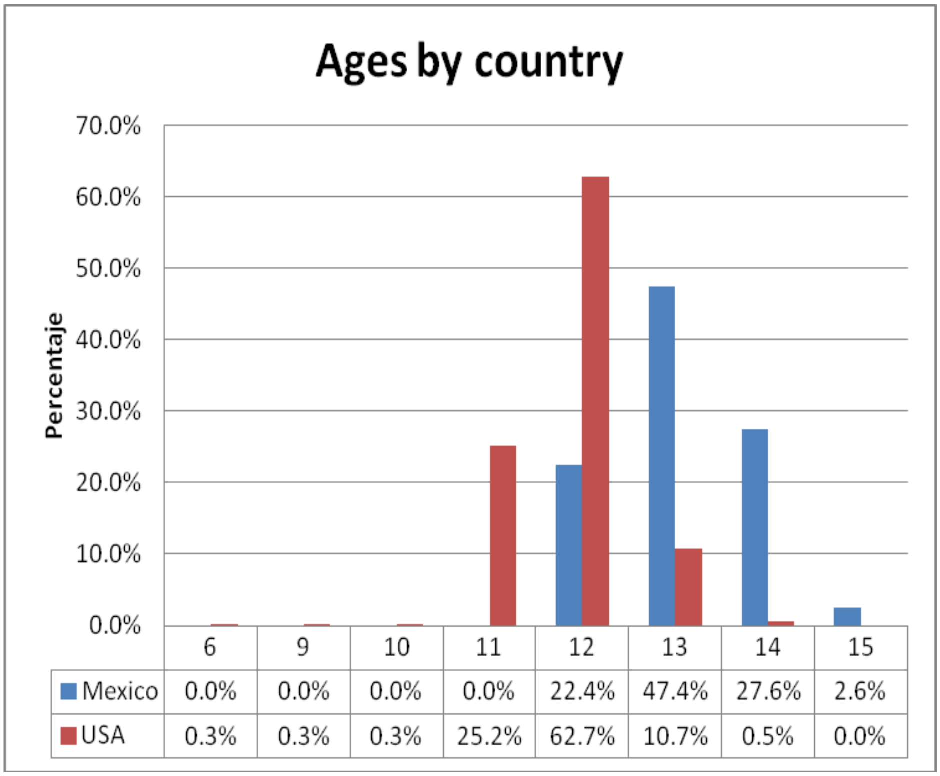

Figure 4.1: Graphics for ages dived by country.

Table 4.1 shows the number of participants (with the percentage of the total sample in parentheses) cross tabulated by gender and country. There is no relation in our sample (*n*=588) between males and females and the country they study in, $\chi^2(1,N=588)=0.015$, p=0.903. In other words, the percentages of males and females in each sample are not different statistically speaking. Figure 4.2 shows a comparison between the percentages of males and females in both countries.

Table 4.1: Country * Gender Cross-tabulation

		GENDER		
		Male	Female	Total
Country	Mexico	76 (12.9)	80 (13.6)	156 (26.5)
	USA	208 (35.4)	224 (38.1)	432 (73.5)
Total		284 (48.3)	304 (51.7)	588 (100)

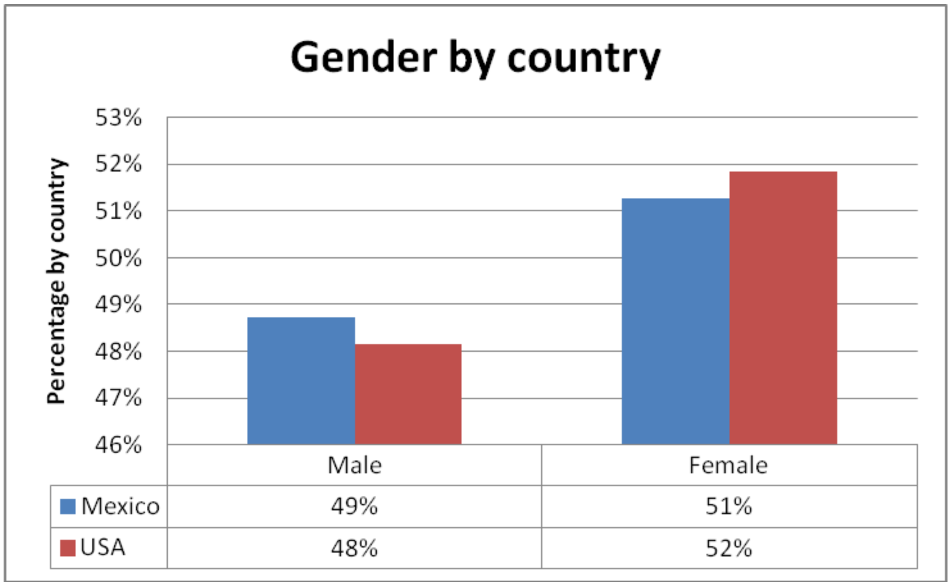

Figure 4.2: Graphics for gender by country.

4.2 RESULTS

After analyzing our demographics, we analyzed measured scientific curiosity to compare it with the results obtained by Ortiz (2006) in her work. Ortiz' results showing a difference in the scientific curiosity level between the sample of middle school students in El Paso and those in Ciudad Juarez persists. Not only was the level greater in Juarez, but the mean found are very similar to those found by Ortiz with a reduction in the standard deviations (see table 4.2 with the Ortiz's results in parentheses).

Table 4.2: Report of means in the scientific curiosity level Spring 2012 (with Ortiz's results in parentheses).

COUNTRY	N	Mean	Std. Deviation	Std. Error of Mean
Mexico	122	109.6967	13.96447	1.26428
	(685)	(109.0518)	(24.13684)	(.92222)
USA	405	99.4420	15.53245	.77181
	(585)	(98.3769)	(18.89171)	(.78108)

In order to determine which inferential test to use, we analyzed the normality of our data using the Kolmogorov-Smirnov and Shapiro-Wilk tests of normality, both tests were significant (K-S = 0.041, p =0.037; S-W = 0.988, p=0.000) which implies that our data differ from the normal distribution. Because of these results, we will verify our parametric analysis (independent samples t-test) with its non-parametric equivalent the Mann-Whitney U Test.

Due to the fact that we had two independent groups, we conducted a t-test for independent samples to see if the differences between the means were still statistically significant. The difference is statistically significant and the results are show in table 4.3.

Table 4.3: Independent Samples T-Test for scientific curiosity differences between the countries.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
CLEVEL	Equal variances assumed	.993	.320	6.539	525	.000	10.2547	1.56829	7.174	13.336
	Equal variances not assumed			6.923	218.889	.000	10.2547	1.48125	7.335	13.174

A Mann-Whitney analysis of these same data confirmed these results with a significance less than 0.001 (U = 14,951). The Cohen's effect size for Ortiz' results was *d* = 0.488 and for our data was *d* = 0.675. Cohen considers the range of effect sizes from 0.2 to 0.5 to be "small", from 0.5 to 0.8 to be "medium," and from 0.8 and up to be "large."

In order to better explain this difference we asked the students directly "Why they like or dislike science?" Because of the lower scientific curiosity level, we expect more students in the US to answer that they dislike science. For the question: Why you like or dislike science? The responses to the question: "Why do you like or dislike science?" were split into two parts, one

for the statement about liking/disliking science, which we refer to as “attitude” and their explanation, which we refer to as “Why”. The “attitude” responses were classified in two groups: “Like” and “Dislike”.

Table 4.4: Crosstabulation table Country*Attitude.

		ATTITUDE		Total
		Dislike	Like	
Country	Mexico	10 (7.4%)	125 (92.6%)	135 (100%)
	USA	62 (15.7%)	333 (84.3%)	395 (100%)
Total		72	458	530

The total number of students who reported liking science in Mexico were 125 (92.6%) out of the 135 who responded to this question. The number of Americans who reported liking science were 333 (84.4%). Before analyzing these differences, we present a comparison of the science curiosity scores of those students who said they like science versus those who said they did not, irrespective of country of origin. One would expect the means of those students liking science to be higher than those who say they do not. Table 4.5 provides the numbers of students, from both countries, who reported liking and disliking science along with their mean scientific curiosity scores. The results of another independent sample t-test, to determine if the mean difference between these two groups is statistically significant are presented in table 4.6. The effect size for this significant difference is “large.” Another Mann-Whitney analysis confirms the results of the t-test with significance less than 0.001 (U = 5504).

Table 4.5: Group Statistics for the mean in scientific curiosity level by attitude towards the science.

	ATTITUDE	N	Mean	Std. Deviation	Std. Error Mean
CLEVEL	Dislike	67	88.3881	14.31989	1.74945
	Like	400	105.2075	14.24629	.71231

Table 4.6: Independent Samples T-Test for difference in means between like and dislike science.

	t-test for Equality of Means			Cohen's effect size
	t	df	Sig. (2-tailed)	d
CLEVEL	6.539	525	.000	1.180

To investigate whether there is a relationship between the number of students who like or dislike science and which country they come from, a contingency table (table 4.7) was created. To test the relationship we calculated a chi-square value coefficient: $\chi^2(1,N=530)$ = 5.888, p=0.015, C=0.105, p=0.015). The significant result indicates that the difference in the numbers of students liking and disliking science in the two countries does not occur simply by chance, but that the relationship between this attitude and country of origin is weak. Volker (2006), describes this as a "small effect."

Table 4.7: Country * Attitude Contingency Table

		ATTITUDE		
		Dislike	Like	Total
Country	Mexico	10	125	135
	USA	62	333	395
Total		72	458	530

The specific answers to the "Why you like or dislike science?" were categorized into 10 major themes to permit a quantitative analysis of the qualitative data obtained from their answers. This categorization was revised and approved by two physics teachers and a math teacher in Juarez for the answers in Spanish and by another physics teacher in El Paso for the answers in English. In the few instances where there was disagreement, an agreement was reached by majority vote.

1.- Because it is boring

2.- Because it is difficult

3.- Because I get benefits

4.- Because it is easy and/or fun

5.- Because we do experiments

6.- Because I find it interesting

7.- Because I learn new things in each class

8.- Because of the teacher

9.- Because the topics covered in class

10.- Another answer

The frequencies for each category by country are presented in the figure 4.3 using percentages.

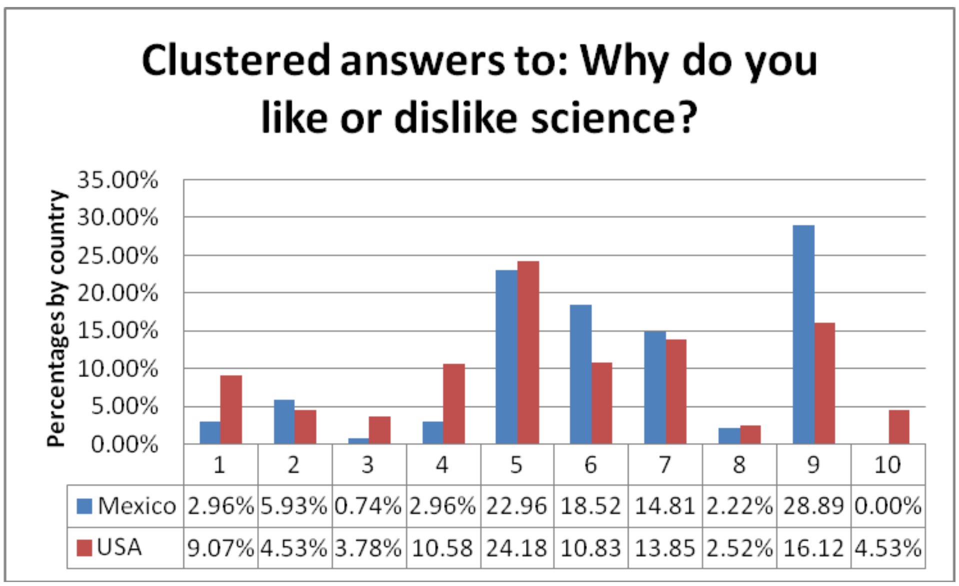

Figure 4.3: Graphic shows the percentage of students by country that their answer fit each category.

To investigate that there is a relationship between the student response categories and which country they come from, a contingency table (table 4.8) was analyzed with the chi-squared test with its respective contingency coefficient ($\chi^2(9,N=532) = 34.669$, p=0.000, C=0.247, p=0.000). This result implies that there is a relationship between how many students

responded in each category and their country of origin. According to Fraenkel and Wallen (2009), a contingency coefficient of 0.25 is still considered small (Volker, 2006).

Table 4.8: Country * Why Category Contingency Table

	Why										Total
Country	1	2	3	4	5	6	7	8	9	10	
Mexico	4	8	1	4	31	25	20	3	39	0	135
US	36	18	15	42	96	43	55	10	64	18	397
Total	40	26	16	46	127	68	75	13	103	18	532

In the figure 4.3 we can see that there is a slightly larger percentage of Mexicans that say that science is difficult (category 2) and on the other hand there are three times as many Americans that say that science is boring (category 1). Table 4.9 is the associated 2x2 contingency table for these two negative responses. The chi-square value testing the relationship between the numbers of students choosing these two responses and their country of origin indicates that there is a relationship between their responses and their country of origin ($\chi^2(1,N=66) = 4.569$, $p=0.033$). The strength of this relationship, as measured by a contingency coefficient of $C=0.254$, is again considered to be weak (Volker, 2006).

Table 4.9: Country * Why (1,2) Contingency Table

			WHY		Total
			Boring	Difficult	
Country	Mexico	Count	4	8	12
		% of Total	6.1%	12.1%	18.2%
	USA	Count	36	18	54
		% of Total	54.5%	27.3%	81.8%
Total		Count	40	26	66
		% of Total	60.6%	39.4%	100.0%

Among the reasons to like science, the two top ranked choices in both countries are experiments (category 5) and topics covered in class (category 9). While the percentage of responses in the experiment category are about the same 23% and 24% respectively (Mexico

and U.S.), in the topics category 29% of the Mexican students cite this reason (many with specific topics mentioned) versus only 16% for the American students. Table 4.10 is the 2x2 contingency table for these responses. The chi-square value testing the relationship between the numbers of students choosing these two responses and their country of origin indicates that there is a relationship between their responses and their country of origin ($\chi^2(1,N=230) = 4.863$, $p=0.027$). The strength of this relationship, as measured by a contingency coefficient of C=0.144, is considered by Volker (2006) to be weak.

Table 4.10: Country * Why (5,9) Contingency Table

			why		Total
			Experiments	Topics	
Country	Mexico	Count	31	39	70
		% of Total	13.5%	17.0%	30.4%
	USA	Count	96	64	160
		% of Total	41.7%	27.8%	69.6%
Total		Count	127	103	230
		% of Total	55.2%	44.8%	100.0%

CHAPTER 5: CONCLUSIONS

The mean science curiosity results obtained in this study compared to the data that Ortiz collected were very similar. The fact that the standard deviations were smaller indicates less variation in response which implies that more of the participants were more certain about their feelings than their peers 6 years ago. This confirmation of mean science curiosity as measured with the CSCS being higher among Mexican middle school students than among their American peers after 6 years, implies a persistent attitude.

As expected, there is a statistically significance difference ($p<0.05$) between the means of scientific curiosity levels between the students that like science and those that do not (table 4.6). This is an example of concurrent validity which lends credibility to the CSCS scores and the honesty or at least consistency of the students in their simple yes/no response to the open-ended question: "Why do you like or dislike science?" Nevertheless, when the relationship between liking or disliking science and being Mexican or American was examined, using the chi-squared test, we find that a relationship exists, $\chi_{(1,N=530)}^2 = 5.88$, $p=0.015$, but that it is a rather weak one (Contingency Coefficient $C=0.105$, $p=0.015$). To put it another way: the measured science curiosity of these students is clearly different depending on whether the students are Mexican or American, but their liking/disliking science responses, while different with statistical significance, are only slightly so.

After classifying all the qualitative data, we found that there are two common reasons to dislike science: it is boring or it is difficult. For liking science the two reasons with the bigger percentages of responses in both cities, Ciudad Juarez and El Paso, are the topics covered in class and the experiments or hands on exercises conducted in class.

In the case of science being boring or difficult, as a reason to dislike science (table 4.9), it is safe to say that there is a relationship ($\chi^2(1, N=66) = 4.569, p = 0.033$) where is more likely for a Mexican student to find it hard and for an American student to find it boring, but this relation is weak (C=0.254, $p = 0.033$). It is necessary to do some personal interviews to gain better insight into what these students consider boring or difficult.

As to why the students like science, there is a statistically significant relationship about experiments being a motivator/attitude enhancer for American students and the topics covered in class enhancing the attitudes of Mexican students ($\chi^2(1, N=230) = 4.863, p = 0.027$) but again, this is a weak relationship (C=0.144, $p = 0.027$). This result suggests a new comparative study between the two curricula.

The reasons for why the students like science that are related to curiosity -novelty and stimuli (Berlyne, 1954)- are: (6) because I find it interesting, and (7) because I learn new things in each class. These two reasons came up more frequently among the Mexican students (19%, 15% respectively) than among American ones (11%, 14% respectively). On the other hand, El Paso's students came up with a wider variety of reasons to like and dislike science. 5% of the American students' answers did not fit into any of the nine categories and these reasons are not similar, so we put them together in a 10^{th} category. Examples of such reasons to dislike science include: “because of the other students”, “because some people don't like them”, and “because to me some of science is fake”. Reasons to like science are: “in some ways”, “its my favorite subject”, “kinda”, “love it sometimes”. To determine the meaning of these kinds of written responses interviews would be necessary.

5.1 LIMITATIONS

One of the principal limitations of this study is that it does not identify clearly if the attitude is toward science in general as a subject or towards a specific science class. Even though by asking the question “Why do you like or dislike science?”, we clearly sought the attitude of the students towards science in general, most of the students answer their feelings toward the science class. Upon reflection, this makes sense. Students refer to “science,” “math,” “social studies,” etc. as specific classes they are taking, not disciplines. We can infer this from responses where the students make statements such as they like science because they have “the best teacher in the world”.

Another limitation of this study, as in many educational studies, is that these results cannot be generalized to the whole population of each country. Whenever, in my conclusions, Mexican students are mentioned, bear in mind that we are referring to these middle school students in Ciudad Juarez, and when it is stated “American students” we are referring to the students in El Paso public schools.

5.2 FUTURE WORK

These results suggest what to look for in any future study involving an interview process to gather more elaborate and clear answers from the students. This study could give a reason to believe that the factors that influence the attitude towards science found in previous research apply to the Mexico-USA border area. So the solutions and ideas they propose there may work also with El Paso middle school students.

An implication of these results relates to projects like one in California that attempts to help improve the classroom environment in order to boost the interest of students in science. This project is called “The iQUEST (investigation for Quality Understanding and Engagement for Student and Teachers) project.” The results of this study suggest that such a program could

have success if implemented in El Paso. The iQUEST program was designed to improve the potential of minorities, mostly Hispanic, to compete in STEM fields (Hayden, Ouyang, Olszewski, & Bielefeldt, 2011).

The iQUEST program addresses both faces of the problem, engaging students in topics in science through labs, activities, and interactions with scientists. You will recall from figure 4.3 that topics and experiments are the reasons that the students most express as the reasons they like science. Other research suggests that the teacher's communication skills and activities in the classroom generate a higher level of engagement. A well prepared teacher and engaging classroom activities can certainly address being bored or difficulties in understanding a subject. For these reasons, it appears worthwhile to try a program such as iQUEST in El Paso. Perhaps such a program will boost interest in science and reduce the percentage of students disliking science from the 14% that was found in this study to less the 9% that is found in the Mexican schools.

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APPENDIX: INSTRUMENTS

Science Curiosity Survey

Are you a boy or girl? ________________ What is your age? ____________________

Please answer the next question in your own words.
Why do you like or dislike science?

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 more about them.	strongly disagree	disagree	uncertain	agree	strongly agree

Escala de Curiosidad Científica

¿Eres niño o niña? ____________________ ¿Cuántos años tienes? ______________

Instrucciones: Contesta la siguiente pregunta en tus propias palabras.
¿Por qué te gusta o no te gusta la ciencia (biología, química o física)?

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

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 cómo 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 qué 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 cómo 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 cómo 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

VITA

Karla Carmona Miranda was born in Mexico City in 1976. The first daughter of Jose Lino Carmona and Maria del Rosario Miranda, she graduated from Bachillerato Tecnico #4, in the Universidad de Colima, in the spring of 1996. Mother of three children: Alexia born in 1999, David born in 2001 and Benjamin born in 2009. She began her studies on Physics Engineer in fall 2004 at Universidad Autonoma de Ciudad Juarez. While studying, she participated in several physics congress in Mexico and some in the United States. Graduate with honors in fall 2009. Published an article in collaboration with Flore-Garcia, Ruiz-Chavez and Salazar-Alvarez (2010, Enero-Abril). **Ecuaciones difrenciales en un contexto físico**. In the magazine Culcyt, 7(36-37), 40-50. Worked as a Physics teacher, in the spring and summer 2010 at the Universidad Autonoma de Ciudad Juarez. In the fall of 2010, she entered the Masters in Physics program at The University of Texas at El Paso. Publish her bachelor thesis as a book (ISBN 978-3-659-02292-0) in June 2012. Awarded "Excellence Student" and "21st century scholar" in the spring 2012.

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This thesis/dissertation was typed by Karla Carmona Miranda.