Survey Research on Communication and Language for English Language Learners and Native English Speakers Enrolled in a College Course on Statistical Literacy

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SURVEY RESEARCH ON COMMUNICATION AND LANGUAGE FOR ENGLISH LANGUAGE LEARNERS AND NATIVE ENGLISH SPEAKERS ENROLLED IN A COLLEGE COURSE ON STATISTICAL LITERACY

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DEDICATION

To Maria and Sofia, my beloved daughters

to Octavio Cervantes, my husband because without
his support, patience, time, and knowledge,
this could have not been possible.
To my parents Alejandra & Victor, because
they taught me that any dream can be true
and for giving me the freedom to go for it.
SURVEY RESEARCH ON COMMUNICATION AND LANGUAGE FOR
ENGLISH LANGUAGE LEARNERS AND NATIVE ENGLISH
SPEAKERS ENROLLED IN A COLLEGE COURSE ON
STATISTICAL LITERACY

by

MARIA G. VALENZUELA, Ind. Electronic Engineer

THESIS

Presented to the Faculty of the Graduate School of
The University of Texas at El Paso
in Partial Fulfillment
of the Requirements
for the Degree of

MASTER OF ARTS IN TEACHING

Department of Mathematical Sciences
THE UNIVERSITY OF TEXAS AT EL PASO
December 2009
ACKNOWLEDGEMENTS

I would like to express my sincere thankfulness to Dr Lawrence Lesser for his disposition, time, and valuable advising during the course of this investigation. His professionalism, knowledge, and constant observation on details were very helpful for the good results of this work. I am thankful with him for accepting to become the thesis chair during the second phase of this research. His enthusiasm was determinant for the development and conclusion of this research, many thanks.

I would also like to thank Dr Amy Wagler for accepting to be part of my committee. Her enormous knowledge contributed to the analysis of the research. Thanks for her valuable time.

I would like to say thank you to Dr Matthew Winsor, for accepting to be my thesis chair in the first stage of my investigation and for being part of my committee in the second stage. His contributions to the elaboration of the survey used in the research were very important.

Finally I like to thank Dr. Hongling Yang for allowing me to apply the survey to her classes. Also, thanks to all students of introductory statistics class for the fall 2009 that agreed to take part of this research.
ABSTRACT

The purpose of this study was to examine in what ways language is a factor that affects the learning process of students in an introductory statistics class. This research used a questionnaire survey instrument called: CLASS, Communication, Language And Statistics Survey that was applied to a total of 137 college students from a large southwestern public university, 83 of these students were self-identified as native English speakers (NOELL) and 53 were self-identified as English learner speakers (ELL) and one was dropped. This research found that in statistical instruction, there are some particular differences in behavior and learning process in the ELL students that differ from NOELL students. ELL students need more time to answer questions and they pretend to understand (e.g. nodding with the head) when the teacher is looking at them. NOELL students think that context will help to understand the meaning of a statistical result.
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CHAPTER 1: INTRODUCTION

1.1 PROBLEM STATEMENT

Studies have shown that language is an issue when statistics classes are taught to students whose first language is not English (Hubbard, 1991; Lesser & Winsor, 2009). The difficulty of learning statistics increases when the statistics terms used in the classes are not frequently used in everyday English and becomes even more difficult when the statistics term has a different meaning than everyday usage, Lesser & Winsor (2009).

Hubbard (1990) stated that in statistics it is common to use ordinary language to set the scene for a problem and this causes confusion between technical and non-technical meaning of words for example, “normally” may or may not refer to a normal distribution. Cobb and Moore (1997) stated that statistics requires a different kind of thinking, because data are not just numbers, they are numbers with a context. Lesser & Winsor (2009) found that there is confusion between subset of language and the setting in which information is communicated.

In this study, the term ELL is used for English Language Learner and NOELL for someone who has the fluency of a native English speaker. Also, NOELL means that they are fluent enough in English that they can negotiate in the technical terms used in statistics. Lesser & Winsor (2009) stated that an English language learner (ELL) speaks English “with enough limitations that he or she cannot fully participate in mainstream English instruction” (p. 5). Other authors have used the term ELL, like Lacelle-Peterson & Rivera in 1994, and Winsor in 2007.

Lesser & Winsor (2009) stated that ELL has been used as alternative to “language minority” or “Limited English Proficient”. Other terms in the literature include English as a
Second Language (ESL), Ball (2007); and Culturally and Linguistically Diverse (CLD) learner, Burnette (2003-2004).

The importance of the research on ELL issues comes from demographic trends; Goldenberg (2008) stated that ELL in the United States comes from over 400 different language backgrounds. This diversity of population reaches our classrooms representing a challenge not only for teachers but also for students. According to the 2007 American Community Survey, U.S. Census Bureau (2007) stated that 80% of the total population in El Paso, Texas is Hispanic or Latino of any race.

The main purpose of this study is to examine how language is a factor that affects the learning process of students in an introductory statistics class.

1.2 RESEARCH QUESTION

Is there a difference between students whose mother tongue is English and students whose mother tongue is another language (e.g., Spanish) with respect to how they encounter language and communication in (introductory) statistics courses?
CHAPTER 2: LITERATURE REVIEW

There are no other studies like the one presented in our study, we wanted to see how ELLs and NOELLs encountered language in a statistics class. A similar study was realized by Batt (2008). She also performed a survey study similar to ours but with certified teachers; our survey study was performed with students. Her study was done with ESL and bilingual education teachers, paraprofessionals, and mainstream teachers who taught to a large number of ELLs in their classrooms; our study was done with ELL students and NOELL students in an introductory statistical class. Her study was about the perception in general of the teachers in ELL education; our study questioned if language is a factor that affects the learning process of students in an introductory statistics class.

This research is based in Lesser & Winsor (2009) research that is about an interview realized to two Latinas that are pre-service teachers and their stronger language is the Spanish. The two strongest findings that emerged from cross-case analysis of the interviews were the importance of the role of context and the confusion between subsets of language. In our research we extended to various issues and examples identified by Lesser & Winsor (2009) because their study was made only with two ELL and in our research we decided to do it with ELL and NOELL students.

2.1 LANGUAGE PROFICIENCY

Cummins (1992) stated that student’s English Proficiency depend on previous education and country of origin. Cummins (1992) notes that students may seem fluent on the surface
through social interaction but that does not mean they have a developed proficiency English. Cummins (1992) also reports that it takes five to seven years to the students to approach grade norms in English Language academic skills. Cummins (1992) stated there is a distinction between “surface fluency” in a language and academically related aspects of language proficiency or “conceptual-linguistic knowledge”, these terms were formalized later as basic interpersonal communicative skills (BICS) and cognitive/academic language proficiency (CALP). The distinction between BICS and CALP was expressed by Shuy (1994); he uses a metaphor through which he compares an iceberg with the level of language students can have. The iceberg is divided in two parts by the level of water in which it is floating: The upper surface of the iceberg is named “visible”; that is, what you can see and the other part of the iceberg that is submerged under the water and it is defined as the “less visible” and therefore more difficult to measure. The upper surface is about knowledge of something we had previously learned. Secondly, we have the comprehension of basic knowledge, and finally, the application of knowledge to specific situations. The part of the iceberg that is submerged shows first, the levels of academic knowledge of the student through process analysis. Secondly, we have the synthesis of those processes and its evaluation through an adequate judgment of ideas or materials that had been provided to the student for this purpose. He points out that most of the methods of language teaching tend to focus on the upper surface of the iceberg, the part that is related to pronunciation, basic vocabulary, and grammar.

In other study, Collier (1987) stated that ELLs who arrives later in the United States have more difficulty acquiring the English proficiency needed to be successful in academic subjects. Collier (1995) stated that to assure cognitive and academic success in a second language a student must be developed to a high cognitive level at least through the elementary-school years.
Hubbard (1990) found that there were difficulties relate to problems with the English language with students with non-English language background others are cultural. She reported that the English courses that many students take before being admitted into a program are frequently inadequate for the study of technical subjects such as statistics which has a language of their own. Winsor (2007) faced a similar problem when teaching ELLs mathematics in a high school setting. He found that there were few materials available for helping ELLs overcome the language barrier in mathematics.

To acquire language proficiency helps students to have the required language to learn concepts and ideas. Carrier (2005) stated that when we talk about the language proficiency needed by English language learners we are talking about the level of English required to comprehend academic content and to participate in activities and assignments. Carrier also stated that it is important that teachers understand that English language learners have two jobs in the classroom: learning a new language while learning new academic content. It is also important for teachers to understand that the learning process on English language learners is not only time-consuming but also, very frustrating in many cases.

2.2 MATHEMATICS LANGUAGE PROFICIENCY

Bullock (1994) says that mathematics can be more properly regarded as a form of language, developed by humankind in order to converse about the abstract concepts of numbers and space. It is important to understand the relationship between the language and the learning process in the mathematics class. Kotsopoulos (2007) note that students feel that mathematics is a foreign language. Kotsopoulos perform a study on ninth grade mathematics classroom, she
found that differences between “natural uses of the language” and “mathematical discourse”. These differences included a mathematical language register (MLR) that contributed to the perception of mathematics sounding like a foreign language; this creates inference for students when they attempt to negotiate meaning in mathematics. Ellerton and Clements (1989) stated that students learning mathematics in their first language are often troubled by the language of formal mathematics and if this is indeed the case then the difficulties experienced by those learning mathematics in their second language would be compounded. Kotsopoulos (2007) confirms that studies by Cummins on ELL students can be generalized to students on mathematics. She suggests that throughout dialog and activities in the classroom, teachers can realize whether or not their ELL students have a good level of understanding of concepts that are being taught because it is very important to have precaution of erroneously believe that students are advanced on language proficiency when they are really not.

Cuevas and Dale (1992) suggest that mathematics can be a language learning experience. In this study they stated that it is a myth that mathematics requires minimal language proficiency. They also suggest that teachers must constantly monitor their ELL students for comprehension given the cognitive demands of mathematics tasks. ELL students faced the task of learning mathematics through a second language and the mathematics teachers can do much giving them the opportunities to experience success in mathematics trough activities they can understand. These positive experiences on the class will provide students certainty and self-esteem for study and increase in language proficiency.

Winsor (2007) used journals with ELL to identify students’ mathematical knowledge and language proficiency. The students were allowed to write in the language they felt most comfortable with, but they were required to write the mathematical terms in English. Through
writing, students were able to learn the meaning of the mathematics concepts in their first language and the mathematics terms in English.

2.3 LANGUAGE PROFICIENCY IN STATISTICS

Cobb and Moore (1997) stated that statistics is a methodological discipline that does not exist by itself but offers to other fields of study a coherent set of ideas and tools for dealing with data. For this reason, to teach statistics, the teacher needs to use a methodology completely different of the one used to teach mathematics. In statistics, there is not only a need to know the theory of mathematics, it is also necessary to learn interpretation of data. Hubbard (1990) pointed out another problem with statistics and it is that statistical texts and lectures tend to use the formal and concise language of mathematics to explain the theory of the subject, as a result of this; many English learner students have difficulty comprehending statistical concepts. They try to focus on key words and hope that this will enable them to deduce meaning of sentences.

English learner students experience difficulties related language. Hubbard (1990) has been keeping records of these kinds of difficulties that ELL faced. Some of these difficulties are related to problems with language, and others are cultural. The problems related to language of statistics are because statistics has many technical words and phrases. Students that have learned conversational English are not adequately prepared to deal with technical English.

Hubbard observation has profound implications on the field of teaching. Cobb and Moore (1997) suggest that a statistical teacher must be like a literature teacher, it has to be ready to supply real examples or real situations where everything is clearly defined. The teachers cannot explain an improvised example because we do not know where data will take us. A statistics teacher must pick examples very carefully and be well prepared with anticipation of difficulties before the class. In statistics, as opposed to mathematics, improvised examples often do not work
well. Cobb and Moore (1997) stated that in statistics the improvised examples do not provide valid interaction between pattern and context. Statisticians are convinced that statistics should be taught as its own science.

Lesser & Winsor (2009) suggests that many aspects of English can influence the learning of statistics for example the use of everyday words like parameter, mean, “at most”, and “less than” can conflict with the statistical meaning of the word.

Lesser & Winsor (2009) note that it is important to remind that the ELL student is learning this list of words that could have three different meanings: the common usage meaning, the mathematical meaning and the statistical meaning.
CHAPTER 3: METHODOLOGY

In order to prove our hypothesis, there is no difference between students whose mother
tongue is English and students whose mother tongue is another language, we constructed a
survey. The survey “CLASS” was administered under the following circumstances:

3.1 THE SETTING

The setting of this research was The University of Texas at El Paso in El Paso, Texas. El
Paso is a city located over a wide border zone in Texas. In El Paso we have The University of
Texas at El Paso. According to census performed by the same University on fall of 2007, there
were more than 19,800 students of which more than 70 percent are Mexican-American. Students
entering UTEP come from diverse origins according to the university census; 83% live here in El
Paso, almost 3% come from other areas of Texas, 9% come from México, and 2% are other
international students.

UTEP is an appropriate site to perform this study because a statistically valid sample of
ELL and NOELL students can easily be taken out of the population and present a quantitative
analysis for this timely subject.

3.2 THE PARTICIPANTS

The participants of the survey were the students that attended the first day of class in the
five sections of the introductory statistics class during the fall 2009 semester at The University of
Texas at El Paso. The researchers choose this class because it is a requirement for pre-service
elementary and middle school teachers and is approved as an option for the university’s core curriculum. The five sections had a combined total of 137 students in the first day’s class.

The participants were provided with an informed consent form (see appendix 2) that included the intention of the study, explained the benefits, risks and confidentiality of the participants. Participants were informed that their participation was completely voluntary and that they could withdraw from the research at any given time and their information could be returned, removed from records or destroyed upon their request even though no one withdraw their participation. No compensation was offered for the survey.

Out of the 137 students that answered the survey, 53 were self-identified as ELL. From these 53 students, 51 choose Spanish as their mother tongue and the other 2 choose the third option for mother tongue that means they have other language different of Spanish or English. The students that self-identified as NOELL were 83 and only one student did not self-identify in any way; this student was dropped from the study analysis.

3.3 THE INSTRUMENT

Based on the results from Lesser & Winsor (2009), an instrument was designed called CLASS, the Communications Language And Statistics Survey (See Appendix 1). The purpose of this instrument was to find answers on how students observe, act, and respond to the knowledge that is taught in the statistics class, and what are the expectations that students have from both the class itself and the teacher. Besides that, the researchers wanted to know about what was the way
students behave under determined situations in the classroom, how they develop when working on teams, and which methods of study they used.

The questions on the survey were designed in consensus by Dr. Lesser, Dr. Winsor, and Valenzuela. The questions were reviewed in detail one by one on several meetings. The first draft was documented on a survey of 70 questions which were used for the pilot. After reviewing the answers of students, some modifications were done to the questions resulting with an increase to 72 questions for the final survey. The questions were structured on a multiple-choice or 7 points Likert scale to facilitate the collection and analysis of data.

The Likert scale is a type of psychometric response scale often used in questionnaires and it is a widely used scale in survey research. When responding to the Likert questionnaire items, the participants specified their level of agreement to a statement. The levels of agreement in the Likert scale utilized responses of: Very strongly disagree, strongly disagree, disagree, neutral, agree, strongly agree and very strongly agree.

The interval scale used in the survey helped achieve a higher level of precision as it represents human behavior and attitudes in a more suitable way. The type of information that needed to be collected played a determinant role in the design of the survey for the study.

The survey contains general questions that allow having available background information on the participants, for example question 1: *what year in school are you?* And question 2: *what kind of pre-service teacher are you?*

There were also included questions directly related to Lesser & Winsor (2009) these questions are completely related with the knowledge on statistics that students must have such as range, mode, and median and also other questions than are related to language confusion such as “less than” and “at least”.

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There were also created questions 14, 15, 16, and 17 with paragraphs from old and new editions of a textbook with the purpose to understand which of the two editions was clearly to understand and accepted by the students.

The questions were classified in terms of those that were significant for the students identified as ELL and those significant for both groups ELL and NOELL. The questions were discussed and agreed to have those ELL related at the end of the survey. In such a way, at question 53 students should identify themselves as either ELL or NOELL. After answering question 53, NOELL students ended the survey and ELL students needed to continue with answers on the second section through question 72.

On the last section the ELL students were questioned about their English language proficiency on a scale from 1 to 10 similar to the question that was done to the study of the two Latinas by Lesser & Winsor (2009). This question is intended to give an idea of the degree of confidence the student has with the English language.

Another considered item was the degree of involvement they have with both languages. The issued question was how many years were they taught entirely in Spanish and in English. Plus a complementary question was also created related to if they had been taught in bilingual classes. They also were asked how well they were using the mathematical and/or statistical terms in Spanish and English and if they were capable of easily translating them from one language to the other.
3.4 THE PILOT

A pilot run was applied with the first version of the survey during the summer of 2009. On June the 26th of 2009 a class of 31 pre-service teachers answered the pilot-survey. An analysis on the answers leaded us to restructure some questions for clarification. Several questions were reworded, for example question 24 was written as follows: “If I did not know what a word means on a statistics test, I would go up and quietly ask the professor”. It was changed trying to be more specific and prevent confusion as follows: “If I did not understand the wording on a statistics test question (and if the wording was not a direct part of what was being tested), I would go up and quietly ask the professor during the test”.

Also question 31 was reworded from: “There is a big difference between how statistical symbols and terms are use in a statistical textbook and how they are used in other contexts (such as newspaper or journal articles)”, to: “There is a big difference between how concepts are expressed in a statistics textbook and how they are expressed in major news sources (e.g., CNN, newspapers, etc.)”.

In questions 35, 36, 37, and 38, we added an “I have no idea” option on the answers with the purpose to have more clear and specific answers. This single additional option meant that the results on the pilot and final surveys were different. On the final survey, ELL students choose this option about twice as often as NOELL students. This difference in rate was statistically significant.

Table 3.1 shows all the questions that have the choice “I have no idea”, we can see the differences between ELL and NOELL, in the column identified with the symbols # and % we can see the number of students that choose the option “I have no idea” and the percent that this
represent for ELL as well as NOELL. This table also shows the z-value and the p-value for each question.

There were computed the two-proportion t-test (two-tailed) for each of these 9 questions (Q4, Q34, Q35, Q36, Q37, Q38, Q41, Q42, and Q43) at the significance level of 0.05. Given hypotheses Ho: \( p_1 = p_2 \) and Ha: \( p_1 \neq p_2 \), where \( p_1 \) is for ELL and \( p_2 \) for NOELL. The results are shown in table 3.1

Table 3.1 Percent of “I have no idea” answers for ELL and NOELL

<table>
<thead>
<tr>
<th>Question</th>
<th>ELL</th>
<th>NOELL</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#, %</td>
<td>N</td>
<td>#, %</td>
<td>N</td>
<td>z-value</td>
</tr>
<tr>
<td>Q4</td>
<td>2, (3.84%)</td>
<td>52</td>
<td>2, (2.40%)</td>
<td>83</td>
<td>0.479</td>
</tr>
<tr>
<td>Q34</td>
<td>1, (1.96%)</td>
<td>51</td>
<td>3, (3.79%)</td>
<td>79</td>
<td>-0.592</td>
</tr>
<tr>
<td>Q35</td>
<td>23, (46%)</td>
<td>50</td>
<td>15, (18.75%)</td>
<td>80</td>
<td>3.320</td>
</tr>
<tr>
<td>Q36</td>
<td>20, (40%)</td>
<td>50</td>
<td>15, (18.51%)</td>
<td>81</td>
<td>2.690</td>
</tr>
<tr>
<td>Q37</td>
<td>8, (15.38%)</td>
<td>52</td>
<td>9, (10.97%)</td>
<td>82</td>
<td>0.747</td>
</tr>
<tr>
<td>Q38</td>
<td>3, (5.76%)</td>
<td>52</td>
<td>3, (3.70%)</td>
<td>81</td>
<td>0.560</td>
</tr>
<tr>
<td>Q41</td>
<td>10, (19.23%)</td>
<td>52</td>
<td>2, (2.40%)</td>
<td>83</td>
<td>3.342</td>
</tr>
<tr>
<td>Q42</td>
<td>2, (3.84%)</td>
<td>52</td>
<td>1, (1.20%)</td>
<td>83</td>
<td>1.013</td>
</tr>
<tr>
<td>Q43</td>
<td>3, (5.76%)</td>
<td>52</td>
<td>5, (6.09%)</td>
<td>82</td>
<td>-0.078</td>
</tr>
</tbody>
</table>
CHAPTER 4: ANALYSIS OF RESULTS

Figure 4.1 shows the results obtained in the survey for the question 53 that asks students about what is their mother tongue, 61 percent of the students that answered the survey chose as their mother tongue English Language, 38 percent chose Spanish, and 1 percent chose other language. This 1 percent was for two students, one of them wrote in the survey that his mother tongue was German and the other did not write anything.

![Figure 4.1 Percent of answers to question 53: What is your mother tongue?](image)

4.1 THE SCALES

The questions in the survey were divided by scales and separated by numerical and nominal questions:

The questions were divided using the following characterization of each scale.
- **Decoding.** - This scale groups the questions when the student is being able to recognize and interpret the academic language. When students are trying to understand academic language in a second language, they have to decode the language for themselves constructing multiple meanings for words. This relates to how strong their CALP is in English as how strong is their CALP in Spanish. CALP is when a student is able to communicate in complex decontextualized academic situations; this includes semantics and functional meaning in an academic and specialized concept (Lesser & Winsor, 2009). Working in mathematics education has used the concept of mathematics register. A register is a language variety associated with a particular situation of use. Common examples of registers include legal talk and baby talk (Moschkovich 2002).

- **Student Practices.** - This scale groups the questions that ask to the students what they do or believe in certain situations. These questions have not a right or wrong answer.

- **Teaching Strategies.** - This scale groups the questions that are related to different teaching methods for ELL found in the literature. These questions ask about certain practice and if the participant agrees with it.

- **Context.** – This scale groups the questions that address the effect of context on the learner. This scale is connected to Lesser & Winsor (2009).

- **Student Background.** – This scale groups the questions that classify the basic information about the student.
• **Content.** – This scale groups the questions that have correct answers of statistical content but they can have wrong choices that are associated with language pitfalls identified in Lesser & Winsor (2009).

• **Transfer between CALPs.** – This scale groups the questions that show the ability of the student to move back and forth between their statistics CALP in English and their statistics CALP in Spanish. CALP is when a student is able to communicate in complex decontextualized academic situations; this includes semantics and functional meaning in an academic and specialized concept (Lesser & Winsor, 2009).

• **Textbook.** – This scale groups the questions that evaluate which of the two wording of a textbook definition would understand clearer (Lesser & Winsor, 2009).

In table 4.1 we can see all the survey questions divided by nominal and numerical questions in each scale. Only question 3 is ratio data. After question 53 the questions in the survey are only for ELL.

<table>
<thead>
<tr>
<th>SCALE</th>
<th>NOMINAL QUESTIONS</th>
<th>NUMERICAL QUESTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decoding</td>
<td>4, 6, 7, 8</td>
<td>11, 12, 19, 23, 46, 49, 70</td>
</tr>
<tr>
<td>Students Practices</td>
<td>9, 63, 64</td>
<td>24, 25, 26, 27, 28, 52</td>
</tr>
<tr>
<td>Teaching Strategies</td>
<td>10, 66</td>
<td>13, 20, 21, 22, 29, 30, 32, 33, 71, 72</td>
</tr>
<tr>
<td>Context</td>
<td>5</td>
<td>18, 31, 45, 47, 48, 50, 51</td>
</tr>
<tr>
<td>Student Background</td>
<td>1, 2, 53, 54, 55, 56a, 56b, 62</td>
<td>3</td>
</tr>
<tr>
<td>Content</td>
<td>34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44</td>
<td></td>
</tr>
<tr>
<td>Transfer Between CALPs</td>
<td>65, 67</td>
<td>57, 58, 59, 60, 61, 68, 69</td>
</tr>
<tr>
<td>Textbook</td>
<td></td>
<td>14, 15, 16, 17</td>
</tr>
</tbody>
</table>
4.2 VALIDITY: EXPLORATORY FACTOR ANALYSIS

To ensure construct validity of key constructs used in this study, exploratory factor analysis was performed for the instrument. According to Vogt (2007), exploratory factor analysis focuses on finding patterns of correlations in the data. It is usually adopted in social scientific studies for the purposes of reducing the number of variables and for detecting structure in the relationships between variables. While factor analysis expresses the underlying common factors for an entire group of variables, it also helps researchers to differentiate these factors by grouping variables into different dimensions or factors, each of which is ideally uncorrelated with the others.

In EFA all the scales were included, decoding, student practices, teaching strategies, context, student background, content, transfer between CALPs and textbook; including the following conditions: questions that were responded for the two groups ELL and NOELL, and questions that not were self-contained. Following this requirements two scales stay out of the EFA: Transfer between CALPs and textbook.

We used Mplus, a software package specifically designed for latent variable analysis to estimate all EFA models. The polychoric correlation matrix and the weighted least squares method were employed for estimating the factor analytic models.

The method of least squares is applied to approximate solutions of over determined systems and may be interpreted as a method of fitting data. The best fit between modeled data and observed data, in its least-squares sense, is an instance of the model for which the sum of squared residuals has its least value, where a residual is the difference between an observed value and the value provided by the model (Gale, 2008).
The polychoric correlation is a technique for estimating the correlation between two theorized normally distributed continuous latent variables, from two observed ordinal variables applied to ordinal data that aims to estimate the correlation between theorized latent variables Gale (2008).

The numerical results of EFA are shown in table 4.2. In the first column we can see the scales, then the quantity of factor models that resulted, in the third column we have the eigenvalues we used the conventional criteria that stated that the number of factors in the model must have the number of eigenvalues greater than 1.

For fit statistics we have the chi-square p-value, the comparative fit index (CFI) and the root mean square error of approximation (RMSEA). The number of appropriate factors for each model was selected considering the model parsimony and according with the eigenvalues as well as the values of fit statistics.

A chi-square test estimated p-value < 0.05 indicated a good fit model as well as a CFI close to 1 and RMSEA less than 0.08.

These are the results and our interpretation of exploratory factor analysis for ELL:

- Decoding scale has originally the following numerical questions: Q11, Q12, Q19, Q23, Q46, and Q49. After EFA we obtained only one-factor model with the following significant questions: Q11, Q12, Q46, and Q49 that we interpreted as “working with statistics CALP register in English”, in other words, this factor can be interpreted as the ability of students to learn statistics concepts due to their academic language proficiency. These questions are related to concepts of register such as morphology and phonology.
• Student practices scale has originally the following numerical questions: Q24, Q25, Q26, Q27, Q28, and Q52. After EFA we obtained two factors, the first factor model has the questions: Q24, Q28, and Q52 that we interpreted as “willingness to expect or ask for help that contrasted with a desire to appear to understand”, in other words, this factor model groups questions related to the student inclination to ask for help opposite to their desire to understand. In this factor model, question 52 asks to the student: If they do not understand what is going on in class, will pretend that I understand when the instructor is looking towards me. The second factor has the questions: Q25, Q26, and Q27 that we interpreted as “student personal understanding”, in other words, this factor model is related to student personal believes and behavior.

• Teaching strategies scales originally had the following numerical questions: Q13, Q20, Q21, Q22, Q29, Q30, Q32, and Q33. After EFA we obtained two factors, the first factor model has only Q20 that we interpreted as “group work”. The second factor has the questions: Q21, Q29, Q30, Q32, and Q33 that we interpreted as “vocabulary” in Q21 we asked to students if: using graphic organizer or pictures to organize my thinking is useful to me in statistics. This question statistically fits with the factor model “vocabulary” and it is supported by Moschkovich (2002) that stated to construct vocabulary implies also to focus on generalize, abstract, and describe patterns, rather than only to use individual words because mathematical communication involves more than language.
Table 4.2 EFA numerical results

<table>
<thead>
<tr>
<th>Scales</th>
<th>Factor model</th>
<th>Eigenvalues</th>
<th>Chi-square p-value</th>
<th>CFI</th>
<th>RMSEA</th>
<th>Significant Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decoding</td>
<td>1</td>
<td>2.05</td>
<td>1.13</td>
<td>0.97</td>
<td>0.77</td>
<td>Factor 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.56</td>
<td>0.52</td>
<td></td>
<td></td>
<td>Q11 0.345</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q12 0.496</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q12 0.496</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q19 0.703</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q23 0.602</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q46 0.602</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q49 0.602</td>
</tr>
<tr>
<td>Student practices</td>
<td>2</td>
<td>1.98</td>
<td>1.42</td>
<td>0.93</td>
<td>0.75</td>
<td>Factor 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.51</td>
<td>0.41</td>
<td></td>
<td></td>
<td>Q24 0.653</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q25 0.678</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q26 0.749</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q27 0.418</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q28 0.422</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q29 0.423</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q30 0.742</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q31 0.702</td>
</tr>
<tr>
<td>Teaching strategies</td>
<td>2</td>
<td>3.309</td>
<td>1.143</td>
<td>1.071</td>
<td>0.75</td>
<td>Factor 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.677</td>
<td>0.487</td>
<td>0.348</td>
<td>0.214</td>
<td>Q13 1.237</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q20 0.538</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q21 0.538</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q22 0.538</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q29 0.538</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q30 0.538</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q31 0.538</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q32 0.538</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q33 0.538</td>
</tr>
<tr>
<td>Context</td>
<td>2</td>
<td>2.726</td>
<td>1.705</td>
<td>0.907</td>
<td>0.793</td>
<td>Factor 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.481</td>
<td>0.214</td>
<td></td>
<td></td>
<td>Q18 -0.399</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q31 0.889</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q45 0.373</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q47 0.373</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q48 0.373</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q49 0.879</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q50 1.009</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q51</td>
</tr>
</tbody>
</table>

- Context scales has originally the following numerical questions: Q18, Q31, Q45, Q47, Q48, Q50, and Q51. After EFA we obtained one factor model but it was not
significant, the model does not fit; for two factor models almost fit. Basically, the null hypothesis there is that the 2 factor model fits and the alternative hypothesis is that a higher order model is needed. Thus, if we get a p>.05 we fail to reject that the 2 factor model fits. Given that we were marginal (p=0.046), we were cautious and concluded it did not fit adequately.

This is our interpretation of explanatory factor analysis for NOELL:

- Decoding scale has originally the following numerical questions: Q11, Q12, Q19, Q23, Q46, and Q49. After EFA we obtained one-factor model that does not fit, and for two factor models does not converge.

- Student practices scale has originally the following numerical questions: Q24, Q25, Q26, Q27, Q28, and Q52. After EFA we obtained one factor model that does not fit, for two factor models do not fit and three factor models was not reasonable.

- Teaching strategies scales has originally the following numerical questions: Q13, Q20, Q21, Q22, Q29, Q30, Q32, and Q33. After EFA we obtained one-factor model that does not fit, and for two factor models does not converge.

- Context scales has originally the following numerical questions: Q18, Q31, Q45, Q47, Q48, Q50, and Q51. After EFA neither one factor nor two-factor model fit the highest p was 0.02.
The previous observations show differences between ELL and NOELL that demonstrate consistencies even tough when the sample size is bigger in NOELL than in ELL.

### 4.3 RELIABILITY: CRONBACH’S ALPHA

Cronbach’s alpha is a measure of internal reliability. Cronbach's alpha is the most common form in reporting internal consistency and reliability coefficient of an instrument. Alpha equals zero when the true score is not measured at all and there is only an error component; 0.00 indicates a complete absence of reliability. Alpha equals 1.0 when all items measure only the true score and there is no error component; this shows a complete consistency (Patten, 2005). Cronbach's alphas of 0.60 or greater indicate strong internal consistency as an indicator of the instrument's reliability (Nunnally, 1976).

Cronbach’s alpha coefficients were run to ensure reliability of each scale of the instrument. We compute every identifiable factor in the EFA models. The ordinal coefficient theta is also a reliability measure. The difference between ordinal coefficient theta and Cronbach’s alpha is that the first takes into account that we have ordinal measures and the Cronbach’s alpha treats it as interval scale. (Zumbo-Gadermann-Zeisser, 2003).

Table 4.3 shows the ordinal coefficient theta and Cronbach’s alpha for the factor models of each scale for ELL.
Table 4.3 Reliability analysis

<table>
<thead>
<tr>
<th>Scale</th>
<th>factor</th>
<th>Ordinal coefficient theta</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>decoding</td>
<td>1</td>
<td>0.635</td>
<td>0.617</td>
</tr>
<tr>
<td>student practices</td>
<td>1</td>
<td>0.481</td>
<td>0.451</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.655</td>
<td>0.604</td>
</tr>
<tr>
<td>teaching strategies</td>
<td>1</td>
<td>not computed</td>
<td>not computed</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.817</td>
<td>0.804</td>
</tr>
<tr>
<td>context</td>
<td>1</td>
<td>not computed</td>
<td>not computed</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>not computed</td>
<td>not computed</td>
</tr>
</tbody>
</table>

In table 4.3 we can see that the decoding scale shows a moderate level of reliability. For the student practices scale, factor 1 shows low reliability and factor 2 shows moderate reliability while the teaching strategies scale cannot be computed for factor 1 because it only has one item, however factor 2 shows high reliability. For the context scale, the EFA model did not have a good fitting and for this reason reliability cannot be computed.

4.4 MULTIPLE REGRESSION ANALYSIS

Multiple regression analysis was performed in Minitab. Vogt (2007) defines regression analysis as a statistical technique used to develop a formula that predicts the correlation between a single dependent variable and more than one independent variable.
The multiple regression analysis was performed only for ELL students with the means of the factors resulting of the following scales: decoding, student practices factor 1 (SP1), student practices factor 2 (SP2), teaching strategies factor 1 (T1), and teaching strategies factor 2 (T2). See table 4.2 as factor reference.

After the analysis of the first results we performed an elimination procedure to reduce the size of the explanatory variable set and make the model more parsimonious.

Next was performed a stepwise regression. The results obtained of this procedure are in table 4.4. On these results we can observe that teaching strategies factor 2 is not in the table 4.4 because it does not add anything to the model. Another restriction that we use in order to make the more parsimonious model was to remove any factor with a p-value greater than 0.15.

<table>
<thead>
<tr>
<th>Scales</th>
<th>Est. model</th>
<th>R-sq (%)</th>
<th>Mallows Cp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decode</td>
<td>Decode = 3.021 + 0.70Q_{26,3}</td>
<td>10.43</td>
<td>4.7</td>
</tr>
<tr>
<td>Student Practices Factor 1 (SP1)</td>
<td>SP1 = 4.922 - 0.05Q_{25,1} - 1.38Q_{22,3}</td>
<td>15.69</td>
<td>-0.9</td>
</tr>
<tr>
<td>Student Practices Factor 2 (SP2)</td>
<td>SP2 = 3.443 + 1.62Q_3 + 0.025Q_3 - 0.56Q_{23,2}</td>
<td>21.39</td>
<td>-2.5</td>
</tr>
<tr>
<td>Teaching strategies Factor 1 (T1)</td>
<td>T1 = 7.621 - 1.13Q_1 + 0.75Q_2</td>
<td>26.98</td>
<td>-3</td>
</tr>
</tbody>
</table>

The interpretation of the estimated multiple regressions in table 4.4 is as follows: If binary variable Q_{55,1}=1, there is a mean 0.05 decrease in student practices factor 1 score given Q_{62,3} is held constant. If binary variable Q_{1}=1, there is a mean 1.13 decrease in teaching strategies score given Q_2 is held constant. The other estimated multiple regressions models are interpreted similarly.
Table 4.4 shows that, when students have more years taught entirely in English, they are more capable to recognizing and interpreting the academic language. This conclusion is supported by Cummins (1992) who stated that to acquire language proficiency takes time and the immigrant students need in average 5 to 7 years of immersion in the language to approach grade norms in English Language academic skills.

For student practices scales factor 1, table 4.4 shows that, when a student has more quantity of years taught in Spanish and he considers writing in English a difficult task, he will have motivation to ask for help even though it is contrasted with a desire to appear he understands. This conclusion is supported in part by the research made for Pappamihiel & Mihai (2006) who stated that it is common that ELL students give a false appearance or pretend understanding.

For student practices factor 2 table 4.4 shows that, the personal understanding of a student increased according to the kind of pre-service teacher that the student is combined with the percent of knowledge that the student itself think to know on an introductory statistical course and if the student considered writing as their most difficult task in English.

For teaching strategies factor 1, table 4.4 shows that, the increase of the use of group work as part of the teaching strategies depends on the quantity of grade-level of years that a pre-service teacher has.

R-squared is called the coefficient of multiple determinations and tells the percent of the variance in the dependent variable that can be explained by all of the independent variables taken together. In table 4.4, the R-sq indicates that the identified predictor explains for example 10.43% of the variance in decode.
Mallow's Cp is used as the criterion for choosing the best subset of predictor when a best subset regression analysis is being performed. Mallows Cp tends to find the best subset that includes only the important predictors of the dependent variables, when this value is smaller, the model is better.

4.5 BACKGROUND QUESTIONS

Table 4.5 shows the results in percentage for Q1, Q2 and Q3. These questions are related to the student background and these are divided in ELL, NOELL, and all the students. The results show that the study was took in a high percentage by Junior Students; the results also show that most of the students are pre-service teachers for elementary school.

The results for Q3 in table 4.5, in this question the students were supposed to choose the percent of knowledge about the introductory statistics course they estimated they knew. The most selected answer for ELL students (with a 20.75%) was zero; meanwhile the answer most selected for NOELL students (with a 15.66%) was 30.
Table 4.5 Background descriptive statistics on Q1, Q2 and Q3

<table>
<thead>
<tr>
<th>Q1. What year in school are you?</th>
<th>ELL</th>
<th>N</th>
<th>Percent</th>
<th>NOELL</th>
<th>N</th>
<th>Percent</th>
<th>ALL</th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>ELL</td>
<td>2</td>
<td>3.77</td>
<td>NOELL</td>
<td>3</td>
<td>3.61</td>
<td>ALL</td>
<td>5</td>
<td>3.68</td>
</tr>
<tr>
<td>Sophomore</td>
<td>ELL</td>
<td>14</td>
<td>26.42</td>
<td>NOELL</td>
<td>32</td>
<td>38.55</td>
<td>ALL</td>
<td>46</td>
<td>33.82</td>
</tr>
<tr>
<td>Junior</td>
<td>ELL</td>
<td>33</td>
<td>62.26</td>
<td>NOELL</td>
<td>37</td>
<td>44.58</td>
<td>ALL</td>
<td>70</td>
<td>51.47</td>
</tr>
<tr>
<td>Senior</td>
<td>ELL</td>
<td>4</td>
<td>7.55</td>
<td>NOELL</td>
<td>10</td>
<td>12.05</td>
<td>ALL</td>
<td>14</td>
<td>10.29</td>
</tr>
<tr>
<td>graduate school</td>
<td>ELL</td>
<td>0</td>
<td>0.00</td>
<td>NOELL</td>
<td>1</td>
<td>1.20</td>
<td>ALL</td>
<td>1</td>
<td>0.74</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q2. What kind of pre-service teacher are you?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary school</td>
</tr>
<tr>
<td>Middle school</td>
</tr>
<tr>
<td>High school</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>missing answers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q3. About what percent of the material in this introductory statistics course do you estimate you already know?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
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<tr>
<td>15</td>
</tr>
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<tr>
<td>70</td>
</tr>
<tr>
<td>75</td>
</tr>
<tr>
<td>80</td>
</tr>
</tbody>
</table>
4.6 NUMERICAL QUESTIONS

Table 4.6 shows the statistical values for numerical questions divided by ELL and NOELL comparing their means and the standard deviation.

Table 4.6 marks these statistically significant results with an asterisk: Q49, Q25, Q52, Q22, and Q51.

Question 49 asks to students if it is confusing to them when words that look and sound similar like mean, median or mode are introduced in the same lesson. The obtained p-value is 0.003 and it means that ELL and NOELL differ from each other. This question comes from Lesser & Winsor (2009) and the result is the same.

Another statistically significant value between ELL and NOELL is for question 25 with p=0.002, this results shows than ELL take more time than NOELL to answer a question. This result supports the recommendation made in Lesser & Winsor (2009).

Question 22 also has a statistical significant value of 0.017 this question is related to the time that a professor waits for a student to answer a question. ELL needs more time to answer a question. This result supports the recommendation made in Lesser & Winsor (2009).

Question 52 asks to students if they do not understand what is going in class, they pretend to understand when the instructor is looking at them. For ELL students this question was statistically significant. Pappamihiel & Mihai (2006) stated that it is common that ELL students falsely give appearance of understanding.

In table 4.6 there were computed the two-sample t-test for each of the questions at the significance level of 0.05. Given hypotheses Ho: \( \mu_1 = \mu_2 \) and Ha: \( \mu_1 \neq \mu_2 \), where \( \mu_1 \) is the mean of ELL and \( \mu_2 \) is the mean of NOELL.
Table 4.6 ELL vs. NOELL for numerical questions

<table>
<thead>
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Question 51 is related to the context, and asks students if they think that knowing the context will help to understand the meaning of a statistical result. The p-value for this question is 0.022 but is interesting to distinguish that it is more significant for NOELL than for ELL. In my personal opinion, it is possible that NOELLs get clarified after examples are provided but in the case of ELLs, they may become more confused when the quantity of provided information on the examples is increased for the same concept. It is very probable that there are more words that the student does not understand and this makes the student getting lost on the large amount of information. It could affirm the Cummins (1992) distinction between “surface fluency” and “conceptual-linguistic knowledge in a language”. This result is different to findings on common literature.

We conducted another analysis for numerical questions in Table 4.7 and Table 4.8. These tables show an analysis of the numerical questions with the neutral response. Because these questions are made in a seven point Likert-scale the answer in “4” is taking as a neutral response. It can be interpreted as ELL students had mean half a point higher than the NOELL students on each question.

Table 4.7 and 4.8 are also divided in scales, with the mean and standard deviation (STDEV) for each question. We also obtained the z-value and the p-value for these questions, the p-value that is denoted with an asterisk is less than 0.05 and 0.01 or less.

In tables 4.7 and 4.8 there were computed the two-proportion t-test (two-tailed) for each of the questions at the significance level of 0.05. Given hypotheses Ho: \( \mu = 4 \) and Ha: \( \mu \neq 4 \), where “4” is the neutral rating on the 7-point likert scale.
In Table 4.7 the questions that are not significant are Q12, Q49, Q24, Q52, Q13, Q50, Q14 and Q16. Q12 and Q49 that belong to the decoding scale are related to the confusion that the students have to understand a concept or group of concepts. Q24 and Q52 that belong to student practices scale are related to the way the student reacts when he does not understand a concept or word during the class. In teaching strategies scale, the only non-significant question is question 13. This question is about if the pre-service teacher can understand if his student has a language problem or a concept problem.

In table 4.8 only questions 50 and 16 are not significant, it means that the p-value is greater than 0.05. Question 50 is in context scale and it asks about if it is confusing for the student that the word “statistics” can refer to quantities computed from a dataset, but it can also refer to the scientific discipline or area of study. Question 16 is in textbook scale and it refers to the preference that students have about certain description in the textbook.

Question 25 has a high statistical significance above the neutral value for ELL students and for NOELL students has a statistical significance but below neutral.
Table 4.7 Testing Ho of neutral response for ELL on numerical questions

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Table 4.8 Testing Ho of neutral response for NOELL on numerical questions

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<td>Q12</td>
<td>81</td>
<td>3.48</td>
<td>1.30</td>
<td>-3.600</td>
<td>3.18E-4*</td>
</tr>
<tr>
<td>Q19</td>
<td>81</td>
<td>2.56</td>
<td>1.10</td>
<td>-11.781</td>
<td>4.98E-32*</td>
</tr>
<tr>
<td>Q23</td>
<td>82</td>
<td>4.57</td>
<td>1.39</td>
<td>3.713</td>
<td>2.04E-4*</td>
</tr>
<tr>
<td>Q46</td>
<td>83</td>
<td>4.88</td>
<td>1.11</td>
<td>7.222</td>
<td>5.13E-13*</td>
</tr>
<tr>
<td>Q49</td>
<td>82</td>
<td>3.43</td>
<td>1.31</td>
<td>-3.940</td>
<td>8.14E-5*</td>
</tr>
<tr>
<td><strong>Student practices</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q24</td>
<td>82</td>
<td>4.43</td>
<td>1.45</td>
<td>2.685</td>
<td>0.007*</td>
</tr>
<tr>
<td>Q25</td>
<td>82</td>
<td>3.61</td>
<td>1.48</td>
<td>-2.386</td>
<td>0.017*</td>
</tr>
<tr>
<td>Q26</td>
<td>82</td>
<td>4.98</td>
<td>1.14</td>
<td>7.784</td>
<td>7.06E-15*</td>
</tr>
<tr>
<td>Q27</td>
<td>82</td>
<td>4.70</td>
<td>1.07</td>
<td>5.924</td>
<td>3.15E-9*</td>
</tr>
<tr>
<td>Q28</td>
<td>82</td>
<td>5.34</td>
<td>0.96</td>
<td>12.639</td>
<td>1.31E-36*</td>
</tr>
<tr>
<td>Q52</td>
<td>83</td>
<td>3.36</td>
<td>1.38</td>
<td>-4.225</td>
<td>2.38E-5*</td>
</tr>
<tr>
<td><strong>Teaching strategies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q13</td>
<td>82</td>
<td>3.72</td>
<td>1.25</td>
<td>-2.028</td>
<td>0.042*</td>
</tr>
<tr>
<td>Q20</td>
<td>82</td>
<td>4.93</td>
<td>1.42</td>
<td>5.930</td>
<td>3.02E-9*</td>
</tr>
<tr>
<td>Q21</td>
<td>82</td>
<td>5.55</td>
<td>1.08</td>
<td>12.996</td>
<td>1.33E-38*</td>
</tr>
<tr>
<td>Q22</td>
<td>82</td>
<td>4.32</td>
<td>1.21</td>
<td>2.394</td>
<td>0.016*</td>
</tr>
<tr>
<td>Q29</td>
<td>81</td>
<td>5.25</td>
<td>1.06</td>
<td>10.613</td>
<td>2.64E-26*</td>
</tr>
<tr>
<td>Q30</td>
<td>82</td>
<td>5.64</td>
<td>0.91</td>
<td>16.319</td>
<td>7.57E-60*</td>
</tr>
<tr>
<td>Q32</td>
<td>82</td>
<td>5.64</td>
<td>0.88</td>
<td>16.875</td>
<td>7.17E-64*</td>
</tr>
<tr>
<td>Q33</td>
<td>82</td>
<td>5.46</td>
<td>1.14</td>
<td>11.597</td>
<td>4.37E-31*</td>
</tr>
<tr>
<td><strong>Context</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q18</td>
<td>82</td>
<td>4.76</td>
<td>1.20</td>
<td>5.735</td>
<td>9.77E-9*</td>
</tr>
<tr>
<td>Q31</td>
<td>82</td>
<td>4.85</td>
<td>1.07</td>
<td>7.193</td>
<td>6.35E-13*</td>
</tr>
<tr>
<td>Q45</td>
<td>83</td>
<td>5.45</td>
<td>0.89</td>
<td>14.842</td>
<td>8.11E-50*</td>
</tr>
<tr>
<td>Q47</td>
<td>83</td>
<td>4.45</td>
<td>1.34</td>
<td>3.059</td>
<td>0.002*</td>
</tr>
<tr>
<td>Q48</td>
<td>82</td>
<td>5.33</td>
<td>0.96</td>
<td>12.545</td>
<td>4.35E-36*</td>
</tr>
<tr>
<td>Q50</td>
<td>83</td>
<td>3.93</td>
<td>1.34</td>
<td>-0.475</td>
<td>0.634</td>
</tr>
<tr>
<td>Q51</td>
<td>83</td>
<td>5.39</td>
<td>0.95</td>
<td>13.330</td>
<td>1.60E-40*</td>
</tr>
<tr>
<td><strong>Textbook</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q14</td>
<td>82</td>
<td>4.37</td>
<td>1.37</td>
<td>2.445</td>
<td>0.014*</td>
</tr>
<tr>
<td>Q15</td>
<td>82</td>
<td>5.16</td>
<td>1.31</td>
<td>8.018</td>
<td>1.08E-15*</td>
</tr>
<tr>
<td>Q16</td>
<td>82</td>
<td>4.00</td>
<td>1.24</td>
<td>0.000</td>
<td>0.999</td>
</tr>
<tr>
<td>Q17</td>
<td>82</td>
<td>4.71</td>
<td>1.21</td>
<td>5.313</td>
<td>1.07E-7*</td>
</tr>
</tbody>
</table>
4.7 NOMINAL QUESTIONS

We see an analysis of nominal questions in table 4.9. This analysis was made in Minitab using the equivalent two-way test of independence. The null is that “student ELLness (i.e., whether one is ELL or NOELL) is independent from student responses on nominal questions”. We obtained the chi-square value and Fisher’s exact p-value. Both p-values are similar in such a way that one confirms the other.

At least 20% of the frequencies are less than 5 in all of the questions except for Q6, Q7, Q8 and Q44. Therefore, Fisher’s exact p-value was calculated with the statistical software called “R”. This value was obtained to make the result stronger.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Chi-square</th>
<th>p-value</th>
<th>Fisher's exact p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4</td>
<td>10.517</td>
<td>0.033</td>
<td>0.024*</td>
</tr>
<tr>
<td>Q6</td>
<td>1.474</td>
<td>0.479</td>
<td>0.453</td>
</tr>
<tr>
<td>Q7</td>
<td>0.819</td>
<td>0.845</td>
<td>0.838</td>
</tr>
<tr>
<td>Q8</td>
<td>0.803</td>
<td>0.849</td>
<td>0.860</td>
</tr>
<tr>
<td>Q9</td>
<td>6.790</td>
<td>0.147</td>
<td>0.109</td>
</tr>
<tr>
<td>Q10</td>
<td>3.804</td>
<td>0.849</td>
<td>0.860</td>
</tr>
<tr>
<td>Q5</td>
<td>0.747</td>
<td>0.688</td>
<td>0.634</td>
</tr>
<tr>
<td>Q1</td>
<td>4.652</td>
<td>0.325</td>
<td>0.313</td>
</tr>
<tr>
<td>Q2</td>
<td>7.118</td>
<td>0.068</td>
<td>0.073</td>
</tr>
<tr>
<td>Q34</td>
<td>4.416</td>
<td>0.621</td>
<td>0.726</td>
</tr>
<tr>
<td>Q35</td>
<td>19.175</td>
<td>0.013</td>
<td>0.004*</td>
</tr>
<tr>
<td>Q36</td>
<td>7.751</td>
<td>0.278</td>
<td>0.214</td>
</tr>
<tr>
<td>Q37</td>
<td>3.381</td>
<td>0.747</td>
<td>0.727</td>
</tr>
<tr>
<td>Q38</td>
<td>5.197</td>
<td>0.519</td>
<td>0.507</td>
</tr>
<tr>
<td>Q39</td>
<td>16.897</td>
<td>0.010</td>
<td>0.009*</td>
</tr>
<tr>
<td>Q40</td>
<td>7.664</td>
<td>0.105</td>
<td>0.094</td>
</tr>
<tr>
<td>Q41</td>
<td>12.591</td>
<td>0.006</td>
<td>0.006*</td>
</tr>
<tr>
<td>Q42</td>
<td>1.097</td>
<td>0.778</td>
<td>0.817</td>
</tr>
<tr>
<td>Q43</td>
<td>0.952</td>
<td>0.621</td>
<td>0.579</td>
</tr>
<tr>
<td>Q44</td>
<td>0.045</td>
<td>0.831</td>
<td>0.860</td>
</tr>
</tbody>
</table>
In table 4.9, the questions marked with an asterisk are statistically significant between values of 0.05 and 0.01. These questions are Q4, Q35, Q39 and Q41. In Q4 we present statistics words with everyday usage. In Q35 we ask to obtain the range of a dataset. In Q39 we want the students to choose words that have a meaning in statistics that differ from everyday usage. In Q41 we ask about the null hypothesis means.

In conclusion we can say that all these questions that were statistically significant are confusing with the meaning of the words. These results support the idea that ELL students have confusion with statistics words that also have everyday usage.

Table 4.10 Nominal Questions for Content Scale

<table>
<thead>
<tr>
<th>Question</th>
<th>ELL fraction correct</th>
<th>NOELL fraction correct</th>
<th>z-value</th>
<th>Two-tailed p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q34</td>
<td>24/49</td>
<td>42/79</td>
<td>-0.461</td>
<td>0.645</td>
</tr>
<tr>
<td>Q35</td>
<td>2/50</td>
<td>17/80</td>
<td>-2.708</td>
<td>0.006*</td>
</tr>
<tr>
<td>Q36</td>
<td>23/50</td>
<td>50/81</td>
<td>-1.760</td>
<td>0.078</td>
</tr>
<tr>
<td>Q37</td>
<td>37/52</td>
<td>60/82</td>
<td>-0.254</td>
<td>0.799</td>
</tr>
<tr>
<td>Q38</td>
<td>7/52</td>
<td>14/81</td>
<td>-0.589</td>
<td>0.555</td>
</tr>
<tr>
<td>Q39</td>
<td>7/52</td>
<td>29/82</td>
<td>-2.787</td>
<td>0.005*</td>
</tr>
<tr>
<td>Q40</td>
<td>4/51</td>
<td>8/83</td>
<td>-0.353</td>
<td>0.723</td>
</tr>
<tr>
<td>Q42</td>
<td>28/52</td>
<td>46/83</td>
<td>-0.179</td>
<td>0.857</td>
</tr>
<tr>
<td>Q43</td>
<td>38/52</td>
<td>65/82</td>
<td>-0.828</td>
<td>0.407</td>
</tr>
<tr>
<td>Q44</td>
<td>23/51</td>
<td>39/83</td>
<td>-0.213</td>
<td>0.831</td>
</tr>
</tbody>
</table>

In table 4.10 we made a comparison between ELL and NOELL students. We performed a two-tailed t-test and obtained the z-value and the p-value for nominal questions related to content, where questions have a “correct answer”. Given hypotheses $H_0: p_1=p_2$ and $H_a: p_1 \neq p_2$, where $p_1$ is for ELL and $p_2$ for NOELL at the significance level of 0.05.
In table 4.10 we can see the proportions of the students that got a correct answer to these questions. Even though for all these questions the NOELL gets a higher proportion of correct answers than ELL, only two questions were statistically significant, Q35 and Q39.

In Q35 the students were to get the range of a dataset and in Q39 the students had to choose some words that had a meaning in statistics that differs from everyday usage. Clearly, these two questions are related to vocabulary knowledge. It is difficult for ELL to apply the meaning of statistical words due to the different meanings they have. For examples, range has the following definitions on *The Real Academia Española Dictionary*: 1. Category of a person with respect to its professional or social situation; 2. Level or category; 3. High social situation; 4. Grace, style; 5. Amplitude of the variation of a phenomenon between the low limit and high limit clearly specified; 6. Line of students, plus the different meanings in English language that according to *The Merriam-Webster Dictionary* these are: 1. A series of things in a line; 2. A series of mountains; 3. An aggregate of individuals in one order; 4. A direction line; 5. A cooking stove; 6. A place that may be ranged over; 7. The horizontal distance between a weapon and target; 8. The space included, covered, or used; 9. A sequence, series, or scale between limits; 10. The limits of a series; 11. The difference between the least and greatest values of an attribute or of the variable of a frequency distribution; 12. The set of values a function may take on; etc.

The multiple contexts for one word that has a meaning in everyday and statistical context created confusion between two or more registers: everyday, mathematics, and statistics registers within English and everyday, mathematics and statistics registers within Spanish (Lesser & Winsor, 2009).
5.1 CONCLUSIONS

This research was made with the purpose to find out if there are differences between ELL and NOELL students related to the language and communication in statistics. Even though the quantity of NOELL students is larger than ELL students, the results obtained in the exploratory factor analysis demonstrated that ELL students do not comprehend the language in the same way that NOELL students do.

In question 22 and 25 we got statistically significant values to confirm that ELL students in particular need a little more time to answer questions. This result supports the recommendation made in Lesser & Winsor (2009) that ELLs need more time to process professor’s questions.

The ELL students also have problems with statistical words that have common usage. For example, in question 49 the ELL found more challenging when words with similar meaning or sound were presented in the same day of classes, this conclusion coincide with the recommendation made for Lesser & Winsor (2009).

These differences have huge implications for curriculum or instruction; if a professor is not familiarized with these differences, he/she would hardly understand that the ELL students do two jobs at the same time: learning a new language while learning a new academic content (Carrier, 2005).

We found one similarity between both groups of students. The two groups agreed that working in groups help them during their learning process.
5.2 LIMITATIONS

A limitation of this research was the self-identification of the student as ELL. Students vary in what percent of the time they speak English. It is possible that students consider that an ELL student is that one who was born in a family that came from a country with Spanish language or on the other hand they may consider that an ELL student is one that speaks Spanish as well as English.

Another limitation of this research is the self-rating language proficiency of the student. Each student can use a different rating. It is possible that a student rates himself as a native speaker because he can speak fluent English but he may have not an acceptable level of knowledge in academic concepts.

The sample size on this research is small. For a perfectly aligned with construct, it is recommended to have a sample size for ELL greater than 200 and also for NOELL.

In Q3: About what percent of the material in this introductory statistical course do you estimate you already know? We do not know that the lowers levels of percent that the students chose were related to the less confident in their knowledge just because they said they knew less of the material. This may simply reflect an actual background difference of prior course taking.

5.3 RECOMMENDATIONS

This research can be done in the future with a different population. It is recommended to try the survey in a larger population. A larger sample size may better support the factorial
structure and repeated exploratory factor analysis on multiple data sets would confirm the validity of the constructs.

For a future use of CLASS, the survey used in this research may be improved. Using the exploratory factor analysis results may help to know which questions in each scale needs to be reworded, or eliminated. For example, it is recommendable that Q56 is split into two questions: 1. Circle the grade-level years you were taught entirely or almost entirely in English and 2. Circle the grade-level years you were taught in a bilingual program with roughly equal amounts of English and Spanish. The questions that do not contribute anything to the survey may be eliminated. For example on teaching strategies, the questions Q21, Q29, Q30, and Q33 on factor one had to be eliminated because they could not be evaluated by EFA.

Using the multiple regression results may help show which questions related to the background of the participants need to be added with the purpose to understand in more detail whether they affect the learning process of an ELL student. It is important to know if the years that the student was immersed in the learning process of any language affects the future behavior and learning of the student. It may also be useful to elaborate some questions about socio-economic aspects to the students (for example, what is the educational level of parents, how many members of the family go or went to college, etc.).

This survey may be applied on non introductory statistical classes as well as in non Spanish speaking English learners. Some considerations related to the ELL student language should apply such as phonetics and grammar.

For future research it is recommended to distinguish several unifactor instruments, for example to have a survey for each scale like content or background.
A practical suggestion, for teachers interested in ELL students, is to get informed about related articles like: “English Language Learners in Introductory Statistics: Lessons Learned from an Exploratory Case Study of Two Pre-service Teachers” Lesser & Winsor, 2009; “Bridging the language barrier in mathematics” Winsor, 2007; and “Teaching statistics to students who are learning in a foreign language” Hubbard, 1990. Understanding the limitation an ELL student has during learning, helps to implement teaching strategies such as provide them more time to answer questions and clarify meaning of words with common use and statistical concept.
REFERENCES


APPENDICES

APPENDIX 1: CLASS, COMMUNICATION, LANGUAGE AND STATISTICS SURVEY

Communication, Language, and Statistics Survey

1. What year in school are you? a) freshman b) sophomore c) junior d) senior e) graduate student
2. What kind of pre-service teacher are you? a) elementary school b) middle school c) high school d) other:_______
3. About what percent of the material in this introductory statistics course do you estimate you already know? _________
   (Whatever number it is between 0% and 100% is okay-- just take your best guess)
4. Which one of these statements best describes your reaction to the following example:
   “In everyday usage, someone who is confounded is confused or mixed up. In statistics, confounded variables have their effects
   mixed together so that it’s hard to tell what effect is due to each variable separately.”
   a) I was familiar with the everyday use of the word ‘confounded’ and the first sentence helped me understand the second one.
   b) I was familiar with the everyday use of the word ‘confounded’, but the first sentence did not help me understand the second one.
   c) I was not familiar with the everyday use of the word ‘confounded’ but the first sentence helped me understand the second one.
   d) I was not familiar with the everyday use of the word ‘confounded’, and the first sentence did not help me understand the second one.
   e) I did not understand the italicized wording or what this question is asking
5. What happens when context is added to the explanations of a concept?
   a) it usually makes it easier because it adds more ways or chances to understand
   b) sometimes it makes it easier, sometimes it makes it harder
   c) it makes no difference at all
   d) it usually makes it harder because there’s now more words to have to read and understand
6. The statistical or mathematical meaning of a word is more confusing to you when:
   a) it has a different meaning of that same word used in an everyday usage
   b) it has the same meaning of that same word used in an everyday usage
   c) that word is not used at all in an everyday usage
7. Connections to everyday language are most helpful to you when they happen:
   a) before the technical academic terms are introduced
   b) after the technical academic terms are introduced
   c) at the same time the technical academic terms are introduced
   d) there is no difference
   e)_______________________
8. The most difficult part of problem solving for you is:
   a) defining and setting up the problem
   b) solving the problem (after I understand the question)
   c) explaining what the answer means
   d) all of the above are equally difficult
9. If a mathematics or statistics instructor uses a word or phrase that you don’t know, what are you most likely to do?
   a) keep listening and try to figure it out from what is said next
   b) raise hand and ask the professor at that moment during class
   c) ask the professor when class is over
   d) stop listening to the professor for a minute while you turn and ask a neighbor
   e) consult an aid such as a math/statistics dictionary
   f) other, please specify_______________________
10. When a teacher or textbook offers more than one way of explaining or describing an important statistical concept, you find it:
    a) very helpful b) somewhat helpful c) somewhat confusing d) very confusing
<table>
<thead>
<tr>
<th></th>
<th></th>
<th>very strongly disagree</th>
<th>strongly disagree</th>
<th>Disagree</th>
<th>neutral</th>
<th>agree</th>
<th>strongly agree</th>
<th>very strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>I will be able to understand a multi-word phrase used in mathematics/statistics as long as I know each of the individual words in the phrase.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>12</td>
<td>It is hard for me to tell when I don't understand a concept because of difficulty with the language used in mathematical/statistical class</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>13</td>
<td>When I am a teacher, it will sometimes be hard to tell when a student doesn’t understand the concept and when the student does understand the concept but just has a problem with the language.</td>
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<td></td>
</tr>
<tr>
<td>14</td>
<td>The following description for finding something called the “first quartile” is written in a way that is understandable to me: “Arrange the observations in increasing order and locate the median M in the ordered list of observations. The first quartile is the median of the observations whose position in the ordered list is to the left of the location of the overall median.”</td>
<td></td>
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<tr>
<td>15</td>
<td>The following description for finding something called the “first quartile” is written in a way that is understandable to me: “Use the median to split the ordered data set into two halves – an upper half and a lower half. The first quartile is the median of the lower half.”</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>16</td>
<td>The following description for something called the “least-squares regression line” is written in a way that is understandable to me: “The least-squares regression line is the line that makes the sum of the squares of the vertical distances of the data points from the line the least value possible.”</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>The following description for something called the “least-squares regression line” is written in a way that is understandable to me: “The least-squares regression line is the line that makes the sum of the squares of the vertical distances of the data points from the line as small as possible.”</td>
<td></td>
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<td>18</td>
<td>Reading examples of statistics in the mass media (such as a daily newspaper) helps me understand statistics concepts.</td>
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<tr>
<td>19</td>
<td>Understanding the basic language of statistics involves knowing what statistical terms and symbols mean and being able to read statistical graphs.</td>
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<tr>
<td>20</td>
<td>Working in groups helps me understand statistics concepts.</td>
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<tr>
<td>21</td>
<td>Using graphic organizers or pictures to organize my thinking is useful to me in statistics.</td>
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<tr>
<td>22</td>
<td>Professors often do not wait enough time after asking a question for me to think about what the question means, and think of an answer.</td>
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<tr>
<td></td>
<td>very strongly disagree</td>
<td>strongly disagree</td>
<td>disagree</td>
<td>neutral</td>
<td>agree</td>
<td>strongly agree</td>
<td>very strongly agree</td>
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<tr>
<td>23</td>
<td>I have sometimes not been able to answer a test question when I knew the concept only because I did not recognize the language that was used.</td>
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<tr>
<td>24</td>
<td>If I did not understand the wording on a statistics test question (and if the wording was not a direct part of what was being tested), I would go up and quietly ask the professor during the test.</td>
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<tr>
<td>25</td>
<td>When a professor asks me a question, I believe that he/she thinks I know less than I really do because it takes me a while to express my thoughts into words.</td>
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<tr>
<td>26</td>
<td>There are times I am not able to think of the correct academic words to describe something, but I am still able to communicate my understanding using gestures, pictures, or objects.</td>
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<td>27</td>
<td>It would be helpful if statistics class could include examples that connect to my cultural background.</td>
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<tr>
<td>28</td>
<td>I expect that if I asked a question about wording on a statistics test that the professor would help me understand the wording as long as it was not a direct part of what was being tested.</td>
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<tr>
<td>29</td>
<td>It is helpful to distinguish statistics terms from words that may be unrelated but that sound the same or almost the same (e.g., discreet and discrete; complement and compliment; median and medium).</td>
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<tr>
<td>30</td>
<td>It is helpful to see connections made between statistics words and real-world objects or situations, such as this example: “just as a median divides a road into two halves (with opposite directions of travel), a median divides a dataset into two halves.”</td>
<td></td>
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<tr>
<td>31</td>
<td>There is a big difference between how statistical concepts are expressed in a statistics textbook and how they are expressed in major news sources (e.g., CNN, newspapers, etc.).</td>
<td></td>
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<tr>
<td>32</td>
<td>It is important to have discussions in class that go beyond vocabulary definitions to include real communication about statistical concepts.</td>
<td></td>
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<tr>
<td>33</td>
<td>It is helpful when a teacher or a textbook takes the time to say how a new word or symbol is supposed to be pronounced.</td>
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</tbody>
</table>

34. In the table below, what fraction of males would you say are smokers?  
   a) 4/6  
   b) 4/10  
   c) 4/16  
   d) 4/20  
   e) 4/30  
   f) 4/40  
   g) I have no idea  

<table>
<thead>
<tr>
<th></th>
<th>Smoker</th>
<th>Nonsmoker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Female</td>
<td>6</td>
<td>14</td>
</tr>
</tbody>
</table>

35. What is the range of the dataset \{1, 2, 3, 4, 6, 6, 13\}?  
   a) 2  
   b) 3  
   c) 4  
   d) 5  
   e) 6  
   f) 7  
   g) 12  
   h) 13  
   i) I have no idea
36. What is the mode of the dataset \{1, 2, 3, 4, 6, 6, 13\}?  
a) 2  b) 3  c) 4  d) 5  e) 6  f) 7  g) 12  h) 13  i) I have no idea

37. What is the median of the dataset \{1, 2, 3, 4, 6, 6, 13\}?  
a) 2  b) 3  c) 4  d) 5  e) 6  f) 7  g) 12  h) 13  i) I have no idea

38. How many numbers in the dataset \{1, 2, 3, 4, 6, 6, 13\} are at least 6?  
a) 2  b) 3  c) 4  d) 5  e) 6  f) 7  g) 12  h) 13  i) I have no idea

39. Which of these words can have a meaning in statistics that differs from everyday usage?  
a) normal  b) random  c) correlation  d) a & b, but not c  e) a & c, but not b  f) b & c, but not a  g) a, b & c

40. In statistics, a parameter is (take your best guess if you don’t know):  
a) a measurement  b) a boundary  c) a population characteristic to be estimated  
d) a constraint  e) the number of values in a dataset

41. In statistics, the “null hypothesis” is what we assume is true until there is significant evidence found against it. What would you say is the null hypothesis for a trial in a court of law?  
a) the defendant is innocent  b) the defendant is guilty  
c) it could be either of the above, depending on what culture you are from  d) I do not understand the question

42. The phrase “not all group averages are equal” tells us that:  
a) some group averages are equal  b) some group averages are not equal  
c) all group averages are not equal  d) I do not understand the question

43. The phrase “we failed to reject the null hypothesis” tells us that  
a) we rejected the null hypothesis  b) we did not reject the null hypothesis  
c) I do not understand the question

44. If someone drives at a constant speed of 50 mph, we can write the equation Miles Travelled = 50*(Hours Driving), which is called “direct variation” in algebra class.  
a) This use of the word “variation” seems similar to the way we say there is “variation” in a set of data.  
b) This use of the word “variation” seems different from the way we say there is “variation” in a set of data.

45. Knowing the context helps me understand the meaning of words in a sentence involving statistical concepts.

46. It is confusing to me that some statistics words have several associated slightly different words such as random, randomized, and randomization.

47. It is confusing to me that some statistics words are pronounced in different ways depending on the context, such as emphasizing the first syllable of survey (SURvey) when it’s a noun and the second syllable (surVEY) when it’s a verb.

48. Knowing the context helps me understand the meaning of a statistical formula.

49. It is confusing to me when words that look and sound similar (mean, median, mode) all get introduced in the same lesson.

50. It is confusing to me the word “statistics” can refer to quantities computed from a dataset, but can also refer to the scientific discipline or area of study I’m taking a course in.

51. Knowing the context helps me understand the meaning of a statistical result.

52. If I don’t understand what is going on in class, I will pretend that I understand when the instructor is looking towards me.
53. What is your mother tongue?  a) English  b) Spanish  c) other: __________

If your answer to question #53 was “a” (English), you’re now DONE with this survey. If it was “b”, please CONTINUE and answer the remaining questions on this survey. If it was “c”, please CONTINUE and answer the remaining questions on this survey. (substituting your own mother tongue when you see the word “Spanish”).

54. Using the (0-10) scale below, give the number that best describes your proficiency with the English language: __________

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Able to speak like an educated native speaker</td>
</tr>
<tr>
<td>9</td>
<td>Able to speak with a great deal of fluency, grammatical accuracy, precision of vocabulary and idiomaticity</td>
</tr>
<tr>
<td>8</td>
<td>Able to speak the language with sufficient structural accuracy and vocabulary to participate effectively in most formal or informal conversations</td>
</tr>
<tr>
<td>7</td>
<td>Able to satisfy most work requirements and show some ability to communicate on concrete topics</td>
</tr>
<tr>
<td>6</td>
<td>Able to satisfy routine social demands and limited work requirements</td>
</tr>
<tr>
<td>5</td>
<td>Able to satisfy most survival needs and limited social demands</td>
</tr>
<tr>
<td>4</td>
<td>Able to satisfy most survival needs and some limited social demands</td>
</tr>
<tr>
<td>3</td>
<td>Able to satisfy most survival needs and minimum courtesy requirements</td>
</tr>
<tr>
<td>2</td>
<td>Able to satisfy immediate need with learned utterances</td>
</tr>
<tr>
<td>1</td>
<td>Able to operate in only a very limited capacity</td>
</tr>
<tr>
<td>0</td>
<td>Unable to function in the spoken language</td>
</tr>
</tbody>
</table>

55. Circle the grade-level years you were taught entirely or almost entirely in Spanish:

<table>
<thead>
<tr>
<th>JARDIN</th>
<th>PRIMARIA</th>
<th>SECUNDARIA</th>
<th>PREPARATORIA</th>
<th>ESCUELA SUPERIOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3</td>
<td>1 2 3 4 5 6</td>
<td>1 2 3</td>
<td>1 2 3</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

56. Circle the grade-level years you were taught entirely or almost entirely in English:
(Put a star next to any year where you were taught in a bilingual program with roughly equal amounts of English and Spanish)

<table>
<thead>
<tr>
<th>PreK</th>
<th>KINDERGARTEN</th>
<th>ELEMENTARY SCHOOL</th>
<th>MIDDLE SCHOOL</th>
<th>HIGH SCHOOL</th>
<th>FRESHMAN</th>
<th>SOPHOMORE</th>
<th>JUNIOR</th>
<th>SENIOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2</td>
<td>1 2 3 4 5 6</td>
<td>7 8 9 10 12 1 2 3 4</td>
<td></td>
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</tbody>
</table>

57. I can correctly use mathematics terms and phrases in English: very strongly disagree strongly disagree disagree neutral agree strongly agree very strongly agree

58. I can correctly use mathematics terms and phrases in Spanish:

59. I can correctly use statistics terms and phrases in English:

60. I can correctly use statistics terms and phrases in Spanish:

61. When I understand a statistics concept in one language, it is easy to use that
62. In a classroom, which of these is most challenging for you?  
   a) reading   b) writing   c) listening   d) speaking

63. When you work in groups in mathematics or statistics class, how do you usually talk with your group members if your group members are bilingual (and could speak in Spanish or English)?  
   a) completely in Spanish   b) mostly in Spanish   c) about as much in Spanish as in English  
   d) mostly in English   e) completely in English

64. When you work by yourself on a statistics problem, how do you usually think?  
   a) completely in Spanish   b) mostly in Spanish   c) about as much in Spanish as in English  
   d) mostly in English   e) completely in English

65. When you know a word in Spanish that relates to the word you’re trying to learn in English, you usually find this to be:  
   a) helpful   b) confusing   c) sometimes a, sometimes b

66. Have you ever seen an English-Spanish handbook of mathematics/statistics terms?  (This handbook does not give definitions or examples, but allows you to look up in one language what the term is in the other language.)  
   a) yes, I have seen this kind of resource  
   b) I have heard of this kind of resource, but have not seen one  
   c) I have not heard of this resource and have never seen one  
   d) I am not sure

67. Which of these statements best describes what you already know about probability or statistics?  
   a) All of what I already know about probability or statistics was learned in Spanish.  
   b) Most of what I already know about probability or statistics was learned in Spanish.  
   c) About half of what I already know about probability or statistics was learned in Spanish.  
   d) Most of what I already know about probability or statistics was learned in English.  
   e) All of what I already know about probability or statistics was learned in English.  
   f) None of the above, because I do not know anything about probability or statistics.

<table>
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<tr>
<th></th>
<th>very strongly disagree</th>
<th>strongly disagree</th>
<th>disagree</th>
<th>neutral</th>
<th>agree</th>
<th>strongly agree</th>
<th>very strongly agree</th>
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</thead>
<tbody>
<tr>
<td>68</td>
<td>If I learn a statistics concept in English, I can easily transfer it to Spanish.</td>
<td></td>
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<tr>
<td>69</td>
<td>If I learn a statistics concept in Spanish, I can easily transfer it to English.</td>
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<tr>
<td>70</td>
<td>When a professor asks a question, I usually translate it into Spanish for myself, and then translate the answer back into English.</td>
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<tr>
<td>71</td>
<td>When I take a statistics test, I believe it would make a big difference if I had access to a list of matching statistics terms in Spanish and English.</td>
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<tr>
<td>72</td>
<td>When I take a statistics test, I believe it would make a big difference if I had access to a general English-Spanish dictionary to translate the “everyday” words used.</td>
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APPENDIX 2: INFORMED CONSENT FORM

University of Texas at El Paso (UTEP) Institutional Review Board
Informed Consent Form for Research Involving Human Subjects

Protocol Title: Communication, Language and Statistics Survey
Principal Investigator: Guadalupe Valenzuela

1. INTRODUCTION

You are being asked to participate in the research project described below. Before agreeing to take part in this research study, it is important that you read the consent form that describes the study. Please ask the study researcher or the study staff to explain any words or information that you do not clearly understand.

2. WHY IS THIS STUDY BEING DONE?

You have been asked to take part in a research study about how communication and language affect learning statistics. The main purpose of this study is to understand better what strengths and difficulties students have with language and learning strategies used in teaching statistics content. Approximately 140-175 subjects (from the estimated number of fall 2009 Stat 1380 sections) are expected to enroll in this study at UTEP. You are being asked to be in the study because you are registered in a fall 2009 introductory statistics class. If you decide to participate in this study, your involvement will last about approximately 20-25 minutes.

3. What is involved in the study?

If you agree to take part in this study, the research team will ask you to complete an anonymous survey during class time.

4. What are the risks and discomforts of the study?

There are no known risks associated with this research.

5. Are there benefits to taking part in this study?
There will be no direct benefits to you for taking part in this study. Participating in this study may help you reflect upon or notice some details about your own process on learning in a statistics class. This research may help the researchers understand what difficulties students face in a statistics class so that more effective teaching strategies can be developed for future students.

**6. What other options are there?**

Participation in this study is optional. There will be no penalties involved if you choose not to take part in this study. We hope, of course, that you will choose to participate because your participation will make the study stronger.

**7. Who is paying for this study?**

This study does not receive funding from any association.

**8. WHAT ARE MY COSTS?**

There are no costs to you beyond the time you are spending on the survey (which is part of class time).

**9. WILL I BE PAID TO PARTICIPATE IN THIS STUDY?**

You will not be paid for taking part in this research study.

**10. What if I want to withdraw, or am asked to withdraw from this study?**

Taking part in this study is voluntary. You have the right to choose not to take part in this study. If you do not take part in the study, there will be no penalty.

If you choose to take part, you have the right to stop at any time. If you do stop, we encourage you to talk to a member of the research group so that they know why you are leaving the study.

**11. Who do I call if I have questions or problems?**

You may ask any questions you have now. If you have questions later, you may call to Guadalupe Valenzuela at 915-921-0697 or send a e-mail to guadalupeva2000@yahoo.com.mx. If you have questions or concerns about your participation as a research subject, please contact the UTEP Institutional Review Board (IRB) at (915-747-8841) or irb.orsp@utep.edu.
12. What about confidentiality?

1. Your part in this study is anonymous. You are not providing your name on the survey and any results will be reported (at meetings or in publications) in a manner that no individual will be identified.
2. Every effort will be made to keep your information confidential, unless disclosure is required by law. Organizations that may inspect and/or copy your research records for quality assurance and data analysis include, but are not necessarily limited to:
   - The sponsor or an agent for the sponsor
   - Department of Health and Human Services
   - UTEP Institutional Review Board

13. Authorization Statement

I have read each page of this paper about the study (or it was read to me). I know that being in this study is voluntary and I choose to be in this study. I know I can stop being in this study without penalty. I can get a copy of this consent form now and can get information on results of the study later if I wish.

Participant Name: ________________________________       Date: _____________

Participant Signature: ________________________________  Time: _____________

Consent form explained/witnessed by: ____________________________

Printed name: ________________________________

Date: _____________       Time: _____________
APPENDIX 3: HISTOGRAMS IN MINITAB FOR EACH QUESTION’S RESULTS.

Histogram of Q1
Normal
What year in school are you?
1= freshman 2=sophomore 3=junior 4=senior 5=graduate

Histogram of Q2
Normal
What kind of pre-service teacher are you?
1=elementary school 2=middle school 3=high school 4=other

Mean 2.706
StDev 0.7315
N1 3 6

Mean 1.695
StDev 1.047
N 128
4.- Which one of these statements best describes your reaction to the following example:

“In everyday usage, someone who is confounded is confused or mixed up. In statistics, confounded variables have their effects mixed together so that it’s hard to tell what effects is due to each variable separately.”

1= I was familiar with the everyday use of the word ‘confounded’ and the first sentence helped me understand the second one.
2= I was familiar with the everyday use of the word ‘confounded’, but the first sentence did not help me understand the second one.
3= I was not familiar with the everyday use of the word ‘confounded’ but the first sentence helped me understand the second one.
4= I was not familiar with the everyday use of the word ‘confounded’, and the first sentence did not help me understand the second one.
5= I did not understand the italicized wording or what this question is asking.
What happens when context is added to the explanations of a concept?

1 = it usually makes it easier because it adds more ways or chances to understand
2 = sometimes it makes it easier, sometimes it makes it harder
3 = it makes no difference at all
4 = it usually makes it harder because there’s now more words to have to read and understand

Histogram of Q6

6. The statistical or mathematical meaning of a word is more confusing to you when:
   1 = it has a different meaning of that same word used in an everyday usage
   2 = it has the same meaning of that same word used in an everyday usage
   3 = that word is not used at all in an everyday usage
Connections to everyday language are most helpful to you when they happen:

1 = before the technical academic terms are introduced
2 = after the technical academic terms are introduced
3 = at the same time the technical academic terms are introduced
4 = there is no difference

Histogram of Q7

The most difficult part of problem solving for you is:

1 = defining and setting up the problem
2 = solving the problem (after I understand the question)
3 = explaining what the answer means
4 = all of the above are equally difficult

Histogram of Q8
If a mathematics or statistics instructor uses a word or phrase that you don’t know, what are you most likely to do? 1=keep listening and try to figure it out from what is said 2=raise hand and ask the professor at that moment during class 3=ask the professor when class is over 4=stop listening to the professor for a minute while you turn and ask a neighbor 5=consult an aid such as a math/statistics dictionary 6=other

Histogram of Q9

When a teacher or textbook offers more than one way of explaining or describing an important statistical concept, you find it:

1=very helpful 2=somewhat helpful 3=somewhat confusing 4=very confusing
I will be able to understand a multi-word phrase used in mathematics/statistics as long as I know each of the individual words in the phrase.

Histogram of Q11

It is hard for me to tell when I don't understand a concept because of difficulty with the language used in mathematical/statistical class.
When I am a teacher, it will sometimes be hard to tell when a student doesn’t understand the concept and when the student does understand the concept but just has a problem with the language.

Histogram of Q13

When I am a teacher, it will sometimes be hard to tell when a student doesn’t understand the concept and when the student does understand the concept but just has a problem with the language.

Histogram of Q14

1=very strongly disagree           2=strongly disagree          3=disagree        4=neutral
5=agree                  6=strongly agree              7=very strongly agree
The following description for finding something called the “first quartile” is written in a way that is understandable to me: “Use the median to split the ordered data set into two halves – an upper half and a lower half. The first quartile is the median of the lower half.”

The following description for something called the “least-squares regression line” is written in a way that is understandable to me: “The least-squares regression line is the line that makes the sum of the squares of the vertical distances of the data points from the line the least value possible.”
The following description for something called the “least-squares regression line” is written in a way that is understandable to me: “The least-squares regression line is the line that makes the sum of the squares of the vertical distances of the data points from the line as small as possible.”
Understanding the basic language of statistics involves knowing what statistical terms and symbols mean and being able to read statistical graphs.

**Histogram of Q19**

*Normal*

- Mean: 5.383
- StDev: 1.020
- N: 133

1=very strongly disagree  2=strongly disagree  3=disagree  4=neutral  5=agree  6=strongly agree  7=very strongly agree

**Histogram of Q20**

*Normal*

- Mean: 4.985
- StDev: 1.440
- N: 135

1=very strongly disagree  2=strongly disagree  3=disagree  4=neutral  5=agree  6=strongly agree  7=very strongly agree
Using graphic organizers or pictures to organize my thinking is useful to me in statistics.

Professors often do not wait enough time after asking a question for me to think about what the question means, and think of an answer.
Histogram of Q23

I have sometimes not been able to answer a test question when I knew the concept only because I did not recognize the language that was used.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
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</thead>
<tbody>
<tr>
<td>Q23</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

1=very strongly disagree           2=strongly disagree          3=disagree        4=neutral
5=agree                  6=strongly agree              7=very strongly agree

Mean 4.726
StdDev 1.390
N 135

Histogram of Q24

If I did not understand the wording on a statistics test question (and if the wording was not a direct part of what was being tested), I would go up and quietly ask the professor during the test.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q24</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

1=very strongly disagree           2=strongly disagree          3=disagree        4=neutral
5=agree                  6=strongly agree              7=very strongly agree

Mean 4.378
StdDev 1.403
N 135
When a professor asks me a question, I believe that he/she thinks I know less than I really do because it takes me a while to express my thoughts into words.

Histagram of Q25

There are times I am not able to think of the correct academic words to describe something, but I am still able to communicate my understanding using gestures, pictures, or objects.
It would be helpful if statistics class could include examples that connect to my cultural background.

I expect that if I asked a question about wording on a statistics test that the professor would help me understand the wording as long as it was not a direct part of what was being tested.
It is helpful to distinguish statistics terms from words that may be unrelated but that sound the same or almost the same (e.g., discreet and discrete; complement and compliment; median and medium).

**Histogram of Q29**

Normal

1 = very strongly disagree  2 = strongly disagree  3 = disagree  4 = neutral  
5 = agree  6 = strongly agree  7 = very strongly agree

Mean 5.239  
StdDev 1.105  
N 134

**Histogram of Q30**

Normal

1 = very strongly disagree  2 = strongly disagree  3 = disagree  4 = neutral  
5 = agree  6 = strongly agree  7 = very strongly agree

Mean 5.615  
StdDev 0.9696  
N 135
There is a big difference between how statistical concepts are expressed in a statistics textbook and how they are expressed in major news sources (e.g., CNN, newspapers, etc.).

Histogram of Q31

It is important to have discussions in class that go beyond vocabulary definitions to include real communication about statistical concepts.
It is helpful when a teacher or a textbook takes the time to say how a new word or symbol is supposed to be pronounced.

**Histogram of Q33**

- Frequency Distribution
- Mean: 5.444
- StDev: 1.117
- N: 135

1 = very strongly disagree  
2 = strongly disagree  
3 = disagree  
4 = neutral  
5 = agree  
6 = strongly agree  
7 = very strongly agree

**Histogram of Q34**

- Frequency Distribution
- Mean: 3.844
- StDev: 1.097
- N: 128

1 = 4/6  
2 = 4/10  
3 = 4/16  
4 = 4/20  
5 = 4/30  
6 = 4/40  
7 = I have no idea
What is the range of the dataset \(\{1, 2, 3, 4, 6, 6, 13\}\)?

Hi stogram of Q35

What is the mode of the dataset \(\{1, 2, 3, 4, 6, 6, 13\}\)?

Hi stogram of Q36
What is the median of the dataset \{1, 2, 3, 4, 6, 6, 13\}?

How many numbers in the dataset \{1, 2, 3, 4, 6, 6, 13\} are at least 6?
Which of these words can have a meaning in statistics that differs from everyday usage?

1 = normal  2 = random  3 = correlation  4 = a & b, but not c  5 = a & c, but not b  
6 = b & c, but not a  7 = a, b & c

In statistics, a parameter is (take your best guess if you don’t know):

1 = a measurement  2 = a boundary  3 = a population characteristic to be estimated  
4 = a constraint  5 = the number of values in a dataset
In statistics, the "null hypothesis" is what we assume is true until there is significant evidence found against it. What would you say is the null hypothesis for a trial in a court of law?

1=the defendant is innocent  2=the defendant is guilty  3=it could be either of the above, depending on what culture you are from  4=I do not understand the question

The phrase “not all group averages are equal” tells us that:

1=some group averages are equal  2=some group averages are not equal  3=all group averages are not equal  4=I do not understand the question
The phrase “we failed to reject the null hypothesis” tells us that

1=we rejected the null hypothesis
2=we did not reject the null hypothesis
3=I do not understand the question

If someone drives at a constant speed of 50 mph, we can write the equation Miles
Travelled = 50*(Hours Driving), which is called “direct variation” in algebra class.

1=This use of the word “variation” seems similar to the way we say there is “variation” in a set of
2=This use of the word “variation” seems different from the way we say there is “variation” in a set
Knowing the context helps me understand the meaning of words in a sentence involving statistical concepts.

Hi stogram of Q45

It is confusing to me that some statistics words have several associated slightly different words such as random, randomized, and randomization.
It is confusing to me that some statistics words are pronounced in different ways depending on the context, such as emphasizing the first syllable of survey (SURvey) when it's a noun and the second syllable (surfVEY) when it's a verb.

Histogram of Q47
Knowing the context helps me understand the meaning of a statistical formula.
It is confusing to me when words that look and sound similar (mean, median, mode) all get introduced in the same lesson.

Histogram of Q49

It is confusing to me the word “statistics” can refer to quantities computed from a dataset, but can also refer to the scientific discipline or area of study I’m taking a course in.
Knowing the context helps me understand the meaning of a statistical result.

**Q51**

If I don't understand what is going on in class, I will pretend that I understand when the instructor is looking towards me.
What is your mother tongue?

1=English                                       2=Spanish                                      3=other

Histogram of QSB

Normal

Mean 1.404
SDev 0.5218
N 136
Using the (0-10) scale below, give the number that best describes your proficiency with the English language.

10 = Able to speak like an educated native speaker
    Able to speak with a great deal of fluency, grammatical accuracy, precision
7 = Able to speak the language with sufficient structural accuracy and vocabulary to participate effectively in most formal or informal conversations
8 = Able to satisfy most work requirements and show some ability to communicate on concrete topics
6 = Able to satisfy routine social demands and limited work requirements
5 = Able to satisfy most survival needs and limited social demands
4 = Able to satisfy most survival needs and some limited social demands
3 = Able to satisfy most survival needs and minimum courtesy requirements
2 = Able to satisfy immediate need with learned utterances
1 = Able to operate in only a very limited capacity
0 = Unable to function in the spoken language

Histogram of Q54

Mean 8.736
StDev 1.456
N 53
How many years were you taught entirely in Spanish?

Histogram of Q55

Mean 7.174
StDev 4.439
N 46

How many years were you taught in a bilingual program?

Histogram of Q56a

Mean 3.615
StDev 2.399
N 13
How many years were you taught in English?

Q56b

Histogram of Q56b

Normal

Frequency

0 4 8 12 16 20

Mean 10.12
Standard Deviation 4.278
N 52

I can correctly use mathematics terms and phrases in English.

Q57

Histogram of Q57

Normal

Frequency

0 5 10 15 20

Mean 5.528
Standard Deviation 1.154
N 53

1=very strongly disagree           2=strongly disagree          3=disagree        4=neutral
5=agree                  6=strongly agree              7=very strongly agree
Histogram of Q58

I can correctly use mathematics terms and phrases in Spanish.

Mean: 4.849
StDev: 1.645
N: 53

Histogram of Q59

I can correctly use statistics terms and phrases in English.

Mean: 5.302
StDev: 1.249
N: 53
I can correctly use statistics terms and phrases in Spanish.

When I understand a statistics concept in one language, it is easy to use that concept in another language.

Histogram of Q60
Normal

Histogram of Q61
Normal
In a classroom, which of these is most challenging for you?

1 = reading  
2 = writing  
3 = listening  
4 = speaking

Histogram of Q62

When you work in groups in mathematics or statistics class, how do you usually talk with your group members if your group members are bilingual (and could speak in Spanish or English)?

1 = completely in Spanish  
2 = mostly in Spanish  
3 = about as much in Spanish as in English  
4 = mostly in English  
5 = completely in English
When you work by yourself on a statistics problem, how do you usually think?

1 = completely in Spanish  
2 = mostly in Spanish  
3 = about as much in Spanish as in English  
4 = mostly in English  
5 = completely in English

Normal

Histogram of Q64

When you know a word in Spanish that relates to the word you're trying to learn in English, you usually find this to be:

1 = helpful  
2 = confusing  
3 = sometimes a, sometimes b
Have you ever seen an English-Spanish handbook of mathematics/statistics terms?

1=Yes, I have seen this kind of resource, 2=I have heard of this kind of resource, but have not seen it, 3=I have not heard of this resource and have never seen one, 4=I am not sure.

Which of these statements best describes what you already know about probability or statistics?

1=All of what I already know about probability or statistics was learned in Spanish.
2=Most of what I already know about probability or statistics was learned in Spanish.
3=About half of what I already know about probability or statistics was learned in Spanish.
4=Most of what I already know about probability or statistics was learned in English.
5=All of what I already know about probability or statistics was learned in English.
6=None of the above, because I do not know anything about probability or statistics.
If I learn a statistics concept in English, I can easily transfer it to Spanish.

**Histogram of Q68**

Mean: 4.5
SD: 1.393
N: 50

1. very strongly disagree
2. strongly disagree
3. disagree
4. neutral
5. agree
6. strongly agree
7. very strongly agree

If I learn a statistics concept in Spanish, I can easily transfer it to English.

**Histogram of Q69**

Mean: 4.365
SD: 1.560
N: 50

1. very strongly disagree
2. strongly disagree
3. disagree
4. neutral
5. agree
6. strongly agree
7. very strongly agree
When a professor asks a question, I usually translate it into Spanish for myself, and then translate the answer back into English.

Histogram of Q70

When I take a statistics test, I believe it would make a big difference if I had access to a list of matching statistics terms in Spanish and English.

Histogram of Q71
When I take a statistics test, I believe it would make a big difference if I had access to a general English-Spanish dictionary to translate the “everyday” words used.

Histogram of Q72

Mean 3.346
SD 1.714
N 52

1=very strongly disagree           2=strongly disagree          3=disagree        4=neutral
5=agree                  6=strongly agree              7=very strongly agree
CURRICULUM VITA

María Guadalupe Valenzuela was born in Hidalgo del Parral, Chihuahua, México. She is the first daughter of Victor Valenzuela and Alejandra Moriel. She received a B.S. degree in Industrial Electronic Engineering from Institute Technologic of Chihuahua in December, 1992. She worked for 5 years as Design Engineer for industries such as Zenith and Phillips in Ciudad Juárez until 2002 when she came to the U.S.A. In the fall of 2007, she entered to the Master of Arts in Teaching Math at the University of Texas at El Paso. She is a co-author of a paper based in part on this research and is currently under review by Statistics Education Research Journal.

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This thesis was typed by the author.