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ABSTRACT

This paper reports on a survey administered to 226 mathematics students at a Texas high school with a 99% Hispanic student population. The survey consisted of items that gauged attitudes toward mathematics and the frequency of traditional versus non-traditional classroom activities. A series of analyses of variance were conducted with gender and mathematics courses as main factors. Findings indicate that female students had more unfavorable attitudes toward mathematics than male students and perceived a greater frequency of traditional activities than did the male students. Students in algebra and geometry classes had worse attitudes toward mathematics than students in calculus classes. Data indicate a greater occurrence of traditional teacher-centered activities than non-traditional inquiry-based activities, and a positive correlation between achievement and attitude. A higher correlation coefficient was associated with negative attitudes and traditional activities than positive attitudes, indicating that negative attitudes toward mathematics are positively correlated with traditional teaching activities. Contains 25 references. (Author/JRH)

Hispanic Students' Attitudes Toward Mathematics and Their Classroom Experience

James A. Telese

University of Texas, Brownsville
School of Education
80 Fort Brown
Brownsville, TX 78520

email: jtelese@utb1.utb.edu

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Abstract

A survey was administered to 226 mathematics students at a high school located with a 99% Hispanic student population. The high school is located in the lower Rio Grande River valley region of Texas. The survey consisted of items that gauged attitudes toward mathematics and the frequency of traditional and non traditional classroom activities. A series of analysis of variance were conducted with gender and mathematics course as main factors. The findings indicated that Hispanic female students attitudes toward mathematics were more unfavorable than male students. Female students perceived a greater frequency of traditional activities than did the male students. Students in algebra and geometry classes had worse attitudes toward mathematics than students in calculus classes. There was a greater occurrence of traditional, teacher-centered activities than nontraditional, inquiry based activities. Student achievement data such as, final course grade, were correlated with attitude and teaching activities. A positive correlation was found between achievement and attitude. The traditional and nontraditional classroom activity variables had near equal and statistically significant correlation coefficients with positive attitudes. A higher correlation coefficient was associated with negative attitude and traditional activities than positive attitudes, indicating that negative attitudes toward mathematics is positively correlated with traditional teaching activities.

Introduction

Algebraic knowledge is being considered a requirement for a new literacy. The point is made by Schoenfeld (1995) who stated:

> With too few exceptions, students who do not study algebra are therefore relegated to menial jobs and are unable often to undertake training programs for jobs in which they might be interested. They are sorted out of the opportunities to be productive citizens in our society (p. 11-12).

Moreover, algebra is a mathematics class that has been described as the "new civil right" (Moses, 1995). The view of algebraic knowledge as a "civil right" implies that this knowledge should be made accessible to all students. Algebra I is the first non arithmetic class encountered by high school and some middle school students. If students are not successful at this stage, then students may not be able to take advantage of this "new civil right." If algebraic knowledge is valued as a contributing factor for success in life, then a question should be asked, what is necessary to foster greater understanding of algebra? Informal observations made while discussing classroom discourse with teachers supports the view that affective factors, such as attitudes and beliefs, have a significant role in mathematics learning and instruction (McLeod, 1992).

Although some researchers (e.g., Garofalo, 1989; Schoenfeld, 1985; Underhill, 1985) have conducted studies on the affective domain, very few studies have been conducted with Latino(a) student populations. For example, McLeod (1992) considered affective factors important for evaluating differences in performance between groups with culturally different backgrounds. In another study, Orr (1987) examined cultural influences on learning mathematics that cause particular problems for minority groups. The purpose of this study was to gain an understanding of Hispanic students' attitudes towards mathematics, in particular Algebra I, and the mathematics teaching tradition encountered by the students in order to direct particular reform efforts. This preliminary study sought to answer the following research questions:

i) What are the attitudes of Hispanic students and their beliefs toward mathematics (i.e., Algebra I)? Related questions are: How do attitudes differ between genders and mathematics courses? How do student attitudes differ among mathematics classes?

ii) What is the predominant mathematics teaching tradition (i.e., Formalist or Growth and Change) presented as perceived by the students? Related questions are: How do male and female students differ in their perception of teaching? What type of teaching traditions are experienced in various mathematics course categories?

The Importance of Examining Beliefs and Attitudes

Although research on the affective domain has remained on the edge of the field, it maintains an active role in mathematics classroom research. Koehler and Grouws (1992) described various levels of mathematics classroom research and recognized the complex role of the affective domain. Of the four described levels, one level assumes that pupil characteristics should be broaden to encompass attitudes as well as achievement. Another level includes cultural factors such as students' gender, race, ethnicity, socioeconomic status and confidence level that can affect teacher practice and student behavior. Beliefs develop gradually over time, are influenced by classroom experiences and the cultural backgrounds of both teacher and students (McLeod, 1992).

Teachers, parents and counselors should have an understanding of what attitudes students harbor towards mathematics. Knowledge of students' attitudes toward mathematics can be used to assist efforts in ensuring future student success in other mathematics courses. A study conducted by the National Action Council for Minorities in Engineering [NACME] (1995) revealed that 60 percent of Latino students intended to drop mathematics at the first opportunity. The results showed that little over half the students surveyed, 53%, indicated that they were encouraged by their teachers to take more advanced mathematics and science.

Attitudes and beliefs toward mathematics play a critical role in future career choices. For example, students who held a more positive attitude toward mathematics were more likely to pursue a mathematics related career than those with worse attitudes (Thorndike-Christ, 1991). The NACME (1995) study revealed an additional influence, teachers and parents, on career choices. A lack of guidance and direction coupled with negative attitudes may further reduce high school students' enrollment in other high school mathematics classes and lucrative careers in mathematics or science. Thus, students will not able to take advantage of their "new civil right."

Algebra involves a great deal of problem solving, and it is an important ability for mathematics students to possess as an outcome of instruction. The manner in which students act or react to mathematical situations is reflective of their attitudes, or beliefs about themselves and mathematics as a discipline generated through classroom experiences (Shoenfeld, 1985). For example, the attribute of persistence when problem solving is related to the belief that mathematics problems should be solved in less than three minutes. If a student holds this belief, then the student who encounters a task that takes substantially longer than three minutes to complete may be leave the problem unsolved. This implies that students should encounter more nonroutine problems and tasks that encourage persistence and severs the umbilical cord of drill and practice routines.

Cultural factors also have an important role in the development of beliefs. The classroom is a complex system. Classroom participants, teachers and students, bring with them beliefs and meanings to the teaching and learning process that must be identified before a response can be made to meet the needs of students (Nickson, 1992). A classroom's social context has an influence on particular attitudes during problem solving. For example, enthusiasm for problem solving is dependent upon a supportive classroom environment with social norms that supports enthusiasm and enjoyment of problem solving (Grouws & Cramer, 1989). Within the social context, parents or individuals in authority also play a role in fostering particular beliefs and attitudes toward mathematics.

Consequently, the affective domain plays an important role in either encouraging or discouraging students to continue with other mathematics classes. Particular attitudes and beliefs develop over time and result from several factors such as, repeated experiences in mathematics classroom. A study conducted by Thorndike-Christ (1991) found that attitudes towards mathematics were predictive of final course grades. Other factors that influence the affective domain include the cultural background and the social context of the mathematics classroom. This cultural background is formed by the participants' gender, ethnicity, and socioeconomic status. Students who experience an algebra classroom where persistence in problem solving is valued will tend to possess this attitude toward algebraic problem solving. It follows that if students develop negative attitudes and beliefs concerning Algebra I, then many students will not be able to enjoy the potential economic benefits as a result of participatory citizenship nourished by algebraic knowledge.

Mathematics Teaching Traditions

According to Gregg (1995), two forms of classroom instruction have developed, "teacher-centered," and "inquiry" mathematics traditions. Teacher-centered instruction features teacher talk that exceeds student talk, the teacher directs instruction to the whole class, rather than working with small groups or individuals, and where students are seated in rows of desks that face the teacher and determines the use of class time (Cuban, 1984).

This picture of mathematics teaching was later described by Cobb, Wood, Yackel, and McNeal (1992) as the school mathematics tradition. Typical classroom practices in this form of instruction include a familiar routine of checking answers from the previous day's assignment, working some of the homework problems on the board, presenting new material with examples and assigning seatwork. Brown, Cooney, & Jones (1990) contended that in the school mathematics tradition, there is an emphasis placed on formalized mathematics where mathematics is presented as a collection of facts and procedures. The act of doing mathematics is considered to be simply replicating procedures presented in class. The teacher and the textbook are the mathematical authorities in the classroom. Hence, students learn mathematical rules that they regard as fixed and self-evident (Cobb et al., 1992).

In comparison, the current reform movement in mathematics education e.g., National Council of Teachers of Mathematics [NCTM], (1989) advocated the development of an "inquiry mathematics tradition." In this tradition, students are encouraged to explore, develop conjectures, prove, and problem solve (Fennema, Carpenter, & Peterson, 1989). The assumption in this tradition is that mathematics teaching should challenge students' conceptual understanding through the resolution of problematic situations. Students are also encouraged to discuss their ideas and results, often within small, cooperative groups, as well as with the teacher. As a result, students are offered opportunities to develop intellectual autonomy, themselves becoming mathematical authorities. The major role of the teacher is one of a facilitator. Students are required to demonstrate their understanding by explaining and justify their actions taken when resolving problematic situations rather than following procedural instructions to obtain correct answers (Gregg, 1995).

The above views of mathematics teaching echo the Growth and Change perspective. The Growth and Change View of mathematics is founded on Popper's (1972) contention that knowledge results from theories that are debated, made public, and tested until falsified by a better theory. Judgment and choice play important roles resulting in different value systems. This view is very similar to the Fallibists view of mathematics where it is seen as a body of knowledge that has socially agreed upon truths, mathematics is changing and new discoveries are being made (Ernest, 1991). Similar to the inquiry tradition, teachers with a growth and change perspective of mathematics allow students to explore, investigate, form hypotheses and test them. Problem solving is central to the growth and change perspective where purposeful activity stems from the problem situations that require reasoning and creative thinking, gathering and applying information, discovering, inventing, communicating and testing ideas (Thompson, 1992). Teachers must be confident in their ability to make decisions regarding the implementation of a curriculum that encourages shared activity where problems and ideas flow back and forth from student to teacher and vice versa where learning and application can become meaningful. Consequently, the classroom takes on a constructivist environment. Students are encouraged to socially construct knowledge, contribute their ideas, try their solutions and challenge the teacher.

Formalists regard mathematics as a discipline, based on the epistemology of logical positivism, with unchanging truths; mathematics is viewed as a process that uses abstract ideas and is rule driven (Nickson, 1994). Mathematical knowledge is not seen as having a social origin but lies outside of human action. Moreover, mathematics as a way of knowing disregards experience and the context of everyday life. The pedagogy usually associated with a Formalist view of mathematics becomes one of what is mathematics really about, not what is the best way to teach mathematics. Teachers who hold the this view tend to teach mathematics as rules to be memorized, and portray mathematics as an infallible discipline. Mathematics is also presented to students in a way that suggests that it is a linear subject, facts and skills related to number are taught, and generally features paper-and-pencil activity. There is also a strong reliance on the textbook, and a strong imbalance between conceptual teaching and skills in favor of skills teaching rather than applications (Porter, Gloden, Freeman, Schmidt, & Schwille, 1988). This type of teaching tends to produce an environment with little teacher-student interaction or among the students and produces an emphasis on right or wrong answers.

A stereotypical mathematics classroom tends to reflect a Formalist View of mathematics. Romberg (1992) described a stereotypical mathematics classroom where students sit in straight rows, the teacher lectures and presents problems, the students then work at their desks practicing similar problems presented by the teacher. A reliance on teacher centered instruction is characteristic of what Paulo Freire described as "banking education," the depositing of information into the students' minds by the teacher, and the students are expected to return it upon request (Aronowitz, 1993). This type of classroom has its own cultural norms including roles for teacher and student. Consequently, teaching from the Formalist perspective creates a barrier erected by its formal and abstract nature, which segregates students from teachers as well as teachers/students from mathematical activity.

Methodology

A survey was administered at a local high school with a 99 percent Hispanic student population. The high school is located in a large district along the lower Rio Grande River valley. The survey was one aspect of a broader research study conducted at the high school.

A random selection of 13 teachers' classrooms was conducted in order to include the following courses: Algebra I, Algebra I-4, Algebra II, Informal Geometry, Geometry, Pre-calculus, and Calculus. The students enrolled in each of the 13 observed classes were administered a questionnaire adapted from Telese (1993). The total number of students surveyed was 226.

The questionnaire consisted of 25 items that examined two areas: i) student attitudes and beliefs toward mathematics, and ii) the classroom activities experienced by the students, which were grouped into traditional and nontraditional activities. The traditional activities such as, teacher lead presentations, and completing worksheets, were included to represent the "school mathematics tradition" and the nontraditional activities such as, completing mathematics projects, and making up their own problems where included to represent the "Growth and Change View" of mathematics.

The students responded to items one to ten, the attitude/belief items, using a Likert scale from one to five where a one represented that the student disagreed and a five represented that the student strongly agreed. Statements that described the various classroom activities associated with were items 11 - 25. For this section, the Likert scale represented the frequency in which the student experienced the stated activity, where a one meant "never" and a five meant "a lot." Ten students were selected for interviews.

The questionnaire was administered to students in 12 classes. Means were calculated for attitudes and classroom activities. Three-way ANOVAs were conducted on the subscales, attitude, and classroom activities (i.e., traditional and non traditional) as dependent variables. The main factors were gender, mathematical subject, and classes. A factor analysis was conducted, but will not be discussed in this paper. The attitude subscale had four items each in the positive and negative attitude toward mathematics.

Student achievement data such as, Texas Assessment of Academic Skills (TAAS) scores, final grade in the high school mathematics classes, and eighth grade first and second semester grades were collected. The achievement measures were correlated with the student survey in order to gauge the effects of attitudes, and activities on achievement. A three-way, gender, course, and grade level, was also conducted using the high school final grade as the dependent variable.

Results

This section presents the overall attitude results by both gender and coursework. The ANOVA results will be presented as well as student interview summaries. The grade level results will also be presented.

Table 1 presents the overall mean responses for the attitude and belief items. The students definitely agreed that mathematics is useful and knowing why an answer is correct is important in mathematics. Also, the students clearly hold a rule-oriented view of mathematics. A contradiction was evident by the means associated with items nine and 10. Although the students' attitudes about mathematics consist of recognizing the importance of mathematics and useful in daily life, they are uncertain whether or not they would like to have a job that uses mathematics. The classroom activities means indicated that the students experienced a Formalist, teacher-centered classroom rather than a reform oriented, Growth and Change classroom. The students' neutrality on several of the attitude items indicated their indifference to the subject.

Table 1

Overall Mean Scores for Attitude Items.

Statement	Mean Response
1. Learning mathematics is mostly memorizing.	3.03 (1.29) n =223
2. Mathematics is interesting.	3.38 (1.35) n = 225
3. Guessing is OK to use in solving mathematics problems.	2.42 (1.30) n = 226
4. There is a rule to follow in solving mathematics problems.	4.36 (1.07) n = 226
5. New discoveries are seldom made in mathematics.	3.10 (1.22) n = 225
6. Mathematics is mostly about symbols rather than ideas.	3.06 (1.28) n = 226
☐ 7. In mathematics, knowing why an answer is correct is important.	4.35 (1.15) n = 225
8. Mathematics is useful in everyday life.	4.27 (1.13) n = 225
9. I would like to have a job that uses mathematics.	3.03 (1.44) n = 222
10. Mathematics is fun.	3.08 (1.38) n = 225

Note: The number in parenthesis is the standard deviation.

The data was disaggregated according to gender. Figure 1 illustrates the overall and gender mean and responses for the attitude items one to ten. Male students agreed slightly more than the female students that mathematics is interesting as indicated by the mean of 3.49 with a standard deviation (SD) of 1.34, and 3.28 with an SD of 1.30 respectively. Both male and female students tended to disagree that guessing in mathematics is OK to do. Female students agreed more strongly than the males that there is always a rule to follow in mathematics. The mean for females on the item was 4.49 and SD of 0.90, and the mean for the males was 4.22 and SD of 1.2. This indicates that both male and female students tended to rely on rules and procedures when solving mathematics problems.

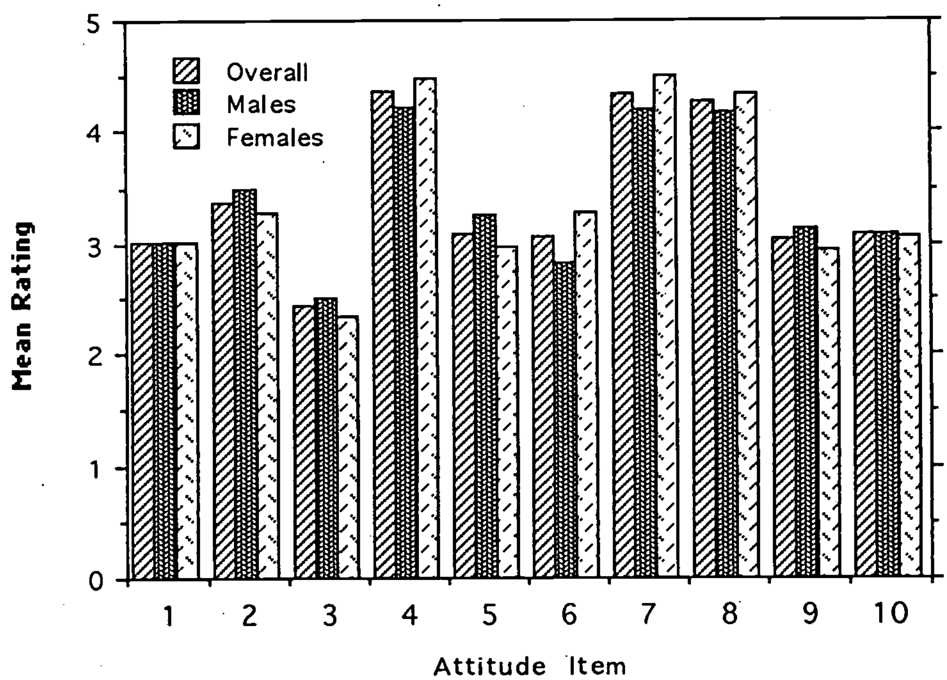

Figure 1. Student Attitude: Overall & Gender Mean Responses.

In general, the students felt that knowing why an answer is correct is important and mathematics is useful in everyday life. The female students' attitude toward knowing why an answer is correct may be related to their reliance on rules, since if an answer is incorrect, the female students would like to know where in the procedure they went wrong. The female students also feel more strongly about mathematics' usefulness than the male students; the means respectively were 4.35 with a SD of 1.07 and 4.17 with a SD 1.19.

The data was further disaggreated by course categories. Figure 2 illustrates student attitudes in Algebra I, Algebra II, Geometry, and Calculus. The Algebra I category includes Algebra 1-4, the Geometry category includes Informal Geometry. Calculus students would rather have a job that use mathematics and enjoy mathematics more than students in other mathematics subjects. In contrast, Geometry and Algebra I students would not like to have a job that uses mathematics and tended to dislike mathematics. In each subject, students felt that knowing why an answer is correct is important. Students in geometry hold a stronger view that mathematics is rule-oriented than students in the other subjects. The calculus students' saw mathematics as being more useful than students in other mathematics courses. They also tended to disagree that mathematics is mostly about memorizing things and believed that mathematics is interesting.

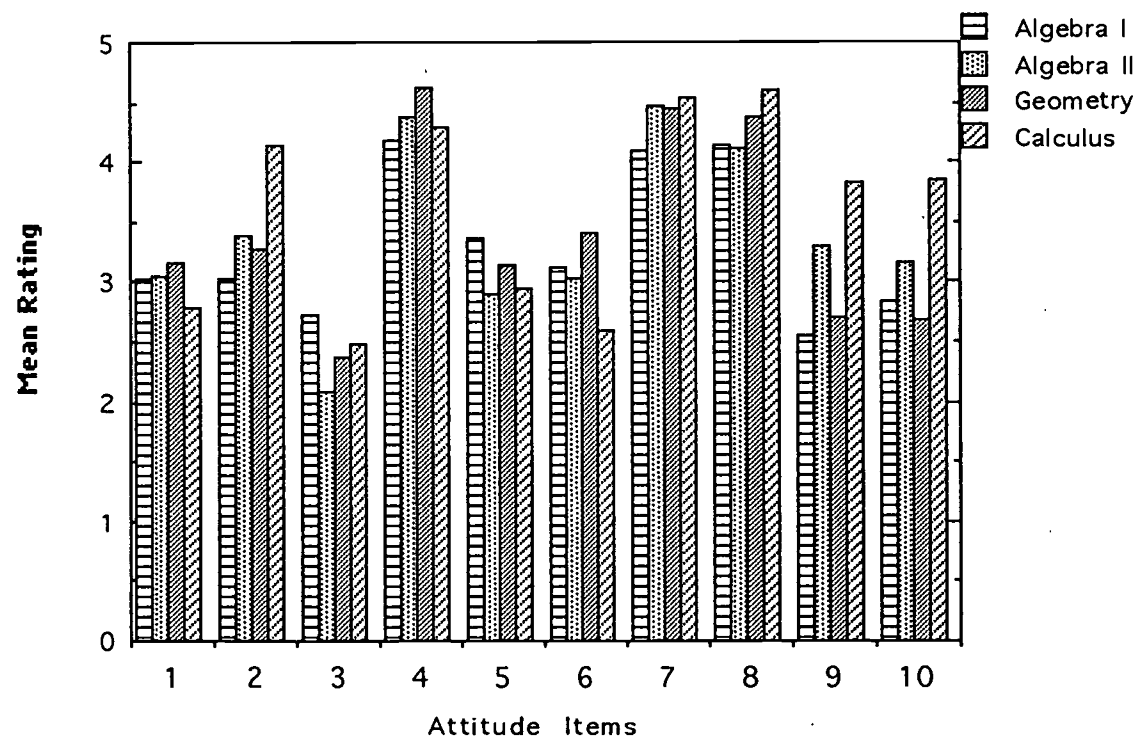

Figure 2. Mean Responses of Attitude Statements by Mathematics Courses.

Table 2 presents the overall means with standard deviations for items related to the classroom activity experienced by students.

Table 2

Means and Standard Deviations for Student Reported Classroom Activity

Classroom Activity	Mean Frequency
11. Do mathematics problems from the textbook.	3.57 (1.24) n = 224
12. Work alone at my desk on mathematics.	3.59 (1.17) n =224
13. Use a computer to work on mathematics problems	1.51 (0.93) n = 224
14. Work on mathematics problems with a group of classmates.	3.20 (1.24) n = 220
15. Show all of my work on a test or quiz.	3.80 (1.25) n = 222
16. Do Mathematics practice worksheets.	3.73 (1.14) n = 222
17. Play mathematics games.	1.73 (1.12) n = 223
18. Have class discussions about mathematics problems.	3.77 (1.27) n = 224
19. Watch the teacher work problems on the board.	4.47 (0.98) n = 223
20. Do mathematics projects.	1.66 (1.09) n = 223
21. Take mathematics tests and quizzes.	4.46 (0.90) n =220
22. Talk to the teacher about how I am doing in mathematics.	3.13 (1.27) n = 224
23. Make up my own mathematics problems to solve.	1.91 (1.23) n = 224
24. Use calculators to solve mathematics problems.	3.42 (1.38) n = 225
25. Students explain how they solve mathematics problems.	3.28 (1.15) n = 225

The overall mean student reported frequency of mathematics classroom activities indicated that the students seldom engage in mathematical projects or investigations. This is indicated by a mean of 1.66 and SD of 1.09. The students almost always watch the teacher work problems on the board as indicated by a mean of 4.47 and SD of 0.98. Students were frequently assigned worksheets, worked problems from the text, and were assessed through tests and quizzes. The means for these two activities are 3.73 with a SD of 1.14, 3.57 with and SD of 1.24, and 4.46 with an SD of 0.90, respectively. Occasionally, students used calculators and almost never used a computer. They were also offered opportunities to explain solutions. Students reported that they worked alone at their desks more often than with other students as indicated by the means of 3.59 with an SD of 1.17 and 3.20 with an SD of 1.24, respectively.

The frequency of classroom activity reported by the students according to gender is illustrated in Figure 3.

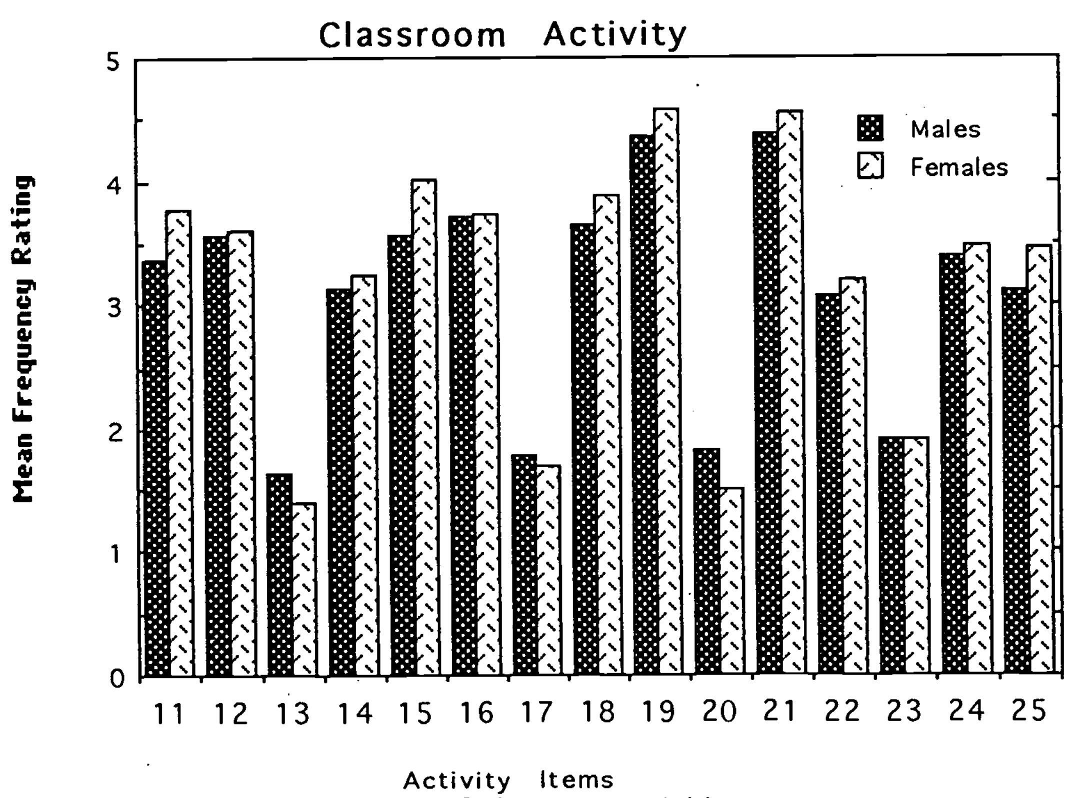

Figure 3. Student Reported Frequency of Classroom Activities

The results are similar to the overall results for all the students surveyed. Both the female and male students reported solving problems from the textbook fairly often. They seldom or rarely use a computer to solve problems, rarely play mathematics games, work on projects, or solve their own problems. Female students reported that they showed all of their work on tests and quizzes more often than the male students. The female students also reported that they work problems from the textbook more often than the male students. The female students reported a greater frequency of working with other students to solve problems, and watch the teacher do problems on the board more often than the male students. Female students tended to talk to the teacher about their progress more often than the male students.

The frequency of classroom activities, 11 to 18, by mathematics subjects is presented in Figure 4.

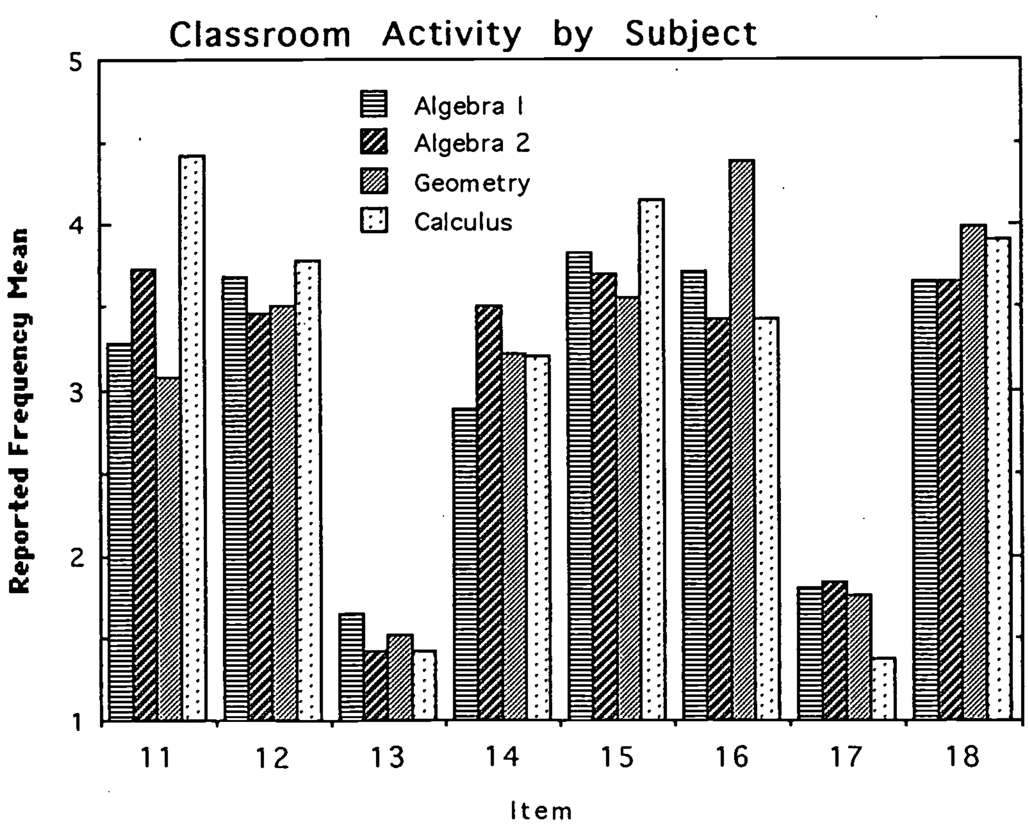

Figure 4. Classroom Activity Frequency Means for Items 11 - 18.

The results parallel the gender breakdown. Students in Calculus reported that they very often complete problems from the textbook. Students in Geometry classes reported that they complete worksheets very often. All the classes, often hold class discussions about mathematics problems with the Geometry students who reported that they have these discussions more often than the other classes. Algebra 2 students reported that they work with other students more often than students in other classes. Students in all the classes reported that they often work alone at their desks.

Figure 5 shows the student reported frequency of classroom activity for items 19 to 25 in the four mathematics courses.

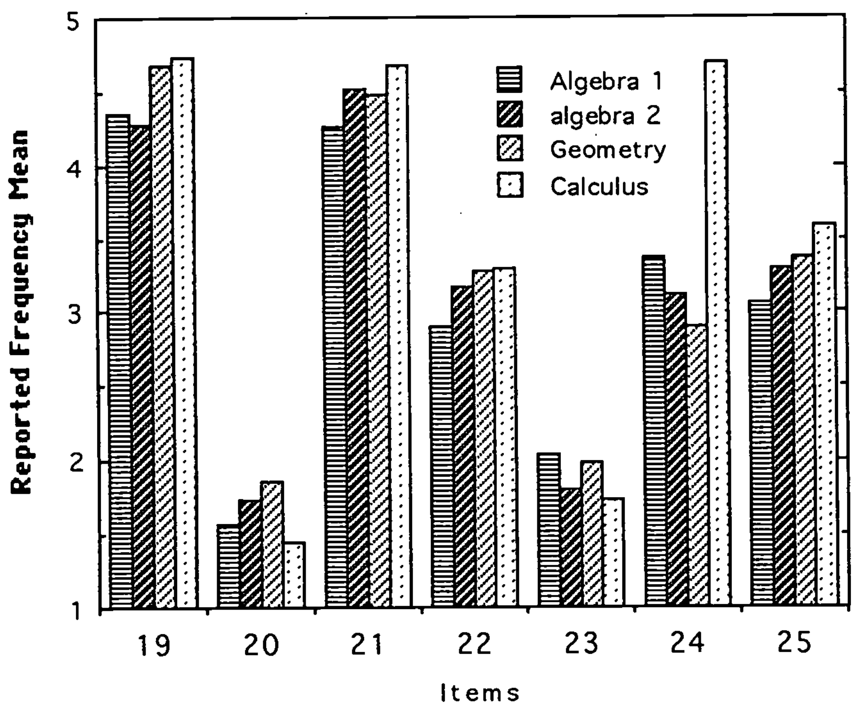

Figure 5. Frequency Means for Classroom Activity Items 19 -25.

Students in all the classes reported that they watch the teacher work problems on the board very often, but the students in Geometry and Calculus reported that this occurs more often in their classes. Similarly, students in each subject are assessed through the use of tests and quizzes. They also have opportunities to talk with the teacher concerning their progress. The Calculus students reported a greater frequency of calculator use than students in the other subjects. Algebra 1, 2, and Geometry students reported occasionally using calculators. Students in each subject reported that they never or rarely have mathematics projects assigned. The Calculus students reported the lowest frequency associated with mathematics projects. Students also reported that they are rarely asked to create and solve their own mathematics problems.

Analysis of Variance.

Table 3 presents the gender mean scores. Overall, the mean scores indicated that the male students held better attitudes towards mathematics than female students, but not statistically significant (see Table 3), with a mean score for males of 14.01 and SD of 4.47, females mean score was 13.66 and SD of 4.01.

Table 3

Gender Mean Scores for Each Dependent Variable

Variable	Males	Females
Positive Attitude	14.01 (4.47) n = 105	13.66 (4.01) n = 115
Negative Attitude	14.26 (3.48) n = 109	15.34 (2.53) n = 112
Traditional Activity	29.31 (5.47) n = 101	31.15 (4.18) n = 114
Non Traditional Act.	7.08 (7.08) n = 106	6.51 (2.91) n = 114

Note: The standard deviation is in parenthesis.

The female students held a more negative attitude toward mathematics than did the male students with a mean score of 15.34 and SD of 2.53 compared to male students mean score of 14.26 and SD of 3.48. The female students perceived a greater frequency of traditional activities than the male students. Both groups of students, males and females, perceived a nearly equal frequency of non traditional activities.

Table 4 presents the presents the means for the variables by mathematics courses for each dependent variable. Students who had Algebra I-4 were combined with the Algebra I students for the Algebra I category. Similarly, Informal Geometry students were combined with Geometry students for the category Geometry. The pre-Calculus and Calculus classes formed the Calculus category. Also, the GT classes associated with the major topic were integrated into that topic.

Table 4

Mean Scores of Attitude and Mathematics Classroom Activity by Mathematics Courses

Mathematics Course	Attitude		Classroom Activity	
	Positive Toward Mathematics (4 items)	Negative Toward Mathematics (4 items)	Traditional (9 items)	Non Traditional (6 items)
Algebra I	12.70 (4.17) n = 64	14.48 (3.74) n = 67	29.25 (5.87) n = 65	6.96 (3.73) n = 68
Algebra II	13.95 (4.28) n = 66	14.49 (2.52) n = 65	29.84 (4.68) n = 63	6.86 (2.94) n = 64
Geometry	13.04 (3.95) n = 50	15.62 (2.83) n = 50	30.73 (4.40) n = 48	7.12 (2.56) n = 49
Calculus	16.40 (3.56) n = 40	14.13 (2.80) n = 39	32.18 (3.39) n = 39	5.92 (1.84) n = 39

Generally, Table 4 indicates that the means for the positive attitude toward mathematics items were lower than the negative attitude toward mathematics means from each course. Students reported a greater frequency of traditional mathematics classroom activities than nontraditional mathematics classroom activities.

In particular, algebra I students had the lowest mean response for the positive attitude items with a 12.70 and SD of 4.17 when compared to students in the other courses. The algebra I students reported a very high frequency of traditional teaching activities, but the mean frequency was lower than the other courses (see Table 5). The calculus classes, on the other hand, reported a greater frequency of traditional teaching activities with a mean of 32.18 and SD of 3.39, while these students held the highest mean score for the positive attitude items. The Geometry students also reported the second largest frequency of traditional activities, 30.73 and SD of 4.40, coupled with the largest negative attitude mean score, 15.62 and SD of 2.83. The students also reported a greater frequency of non traditional activities than in any other class with a mean of 32.18 and SD of 3.39. The largest mean, 7.12 and SD of 2.16, occurred for the variable non traditional activity.

A three-way ANOVA using gender, mathematics course and grade level was conducted on each of the subscales, positive and negative attitudes, and traditional and non traditional activities, as dependent variables. Table 5 presents the three-way ANOVA results for positive attitudes toward mathematics. The model was statistically significant with an F-value of 1.86 and $p < 0.05$.

Table 5

Three-Way ANOVA for Positive Attitude Toward Mathematics

Source of Variation	df	Sum of Squares	Mean Squares	F-value
Error	192	3107.29	16.18	
Gender	1	6.67	6.67	0.41
Course	3	383.31	127.77	7.89**
Gender (G) *Course (C)	3	27.79	9.26	0.57
Grade Level(GL)	3	51.10	17.03	1.05
G*GL	3	44.19	14.73	0.91
C*GL	7	275.64	39.38	2.43*
G*C*GL	7	25.44	3.63	3.63

*p < 0.05
**p < 0.0001

Students differed in positive attitudes depending on the course in which they were enrolled since the variable, mathematics course, was found to be statistically significant with an F-value of 7.89 and $p < 0.001$. A Tukey's Studentized Range Test indicated that the students in Calculus had a more favorable outlook toward mathematics than students in either in Algebra I, Algebra II, and Geometry. Although the mean for female students was greater than the male mean for positive attitude, the interaction between course and gender was not found to be statistically significant. There was a significant interaction, mathematics course-by-grade level, with an F-value of 2.43 and $p < 0.05$.

Students' positive attitudes were influenced by the mathematics course and grade level. Figure 6 illustrates the mathematics course-by-grade level interaction.

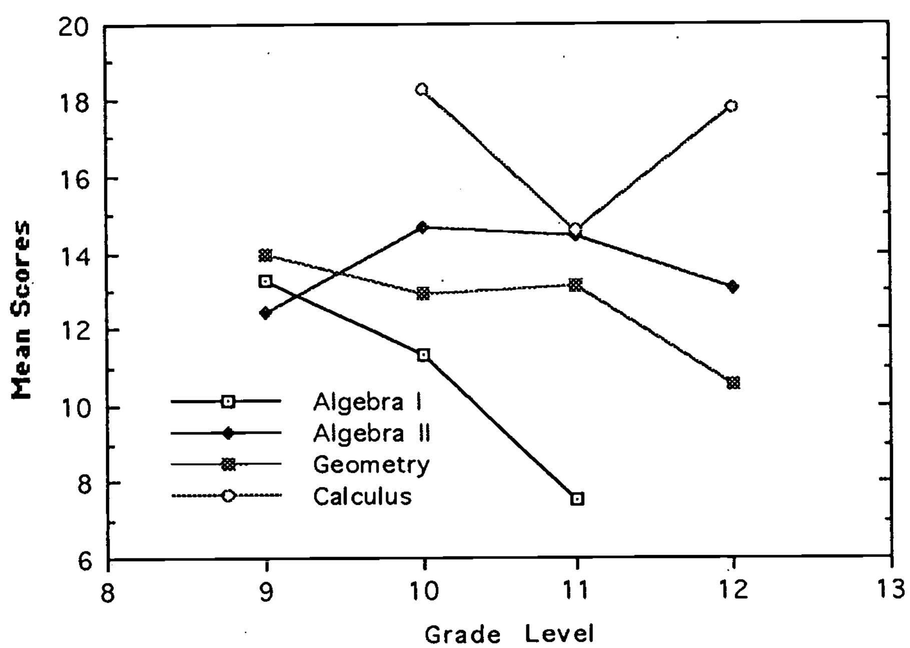

Figure 6. Positive Attitude: Mathematics Course-by-Grade level.

The degree of positive attitudes is similar among the freshmen regardless of the course. It is interesting to note that the eleventh-graders in calculus have a lower mean score than students in tenth or twelfth grades. Generally, the calculus students have greater mean scores for positive attitude than students in the other classes. The largest difference occurred in the eleventh grade where students taking Algebra I have a low mean positive score in relation to eleventh graders in the upper level courses. A similar result occurred for the twelfth graders in the calculus course; they had a better attitude toward mathematics than any other student, especially when compared to 12th graders taking geometry who had the lowest mean score for positive attitude among twelfth-graders. In Algebra II, the positive attitude mean score is low for the freshmen but then improves for sophomores and juniors then decreases for seniors.

Table 7 presents the results of the three-way ANOVA for negative attitudes towards mathematics for gender, mathematics course, and gender.

Table 7

Three-Way ANOVA for Negative Attitude Toward Mathematics

Source of Variation	df	Sum of Squares	Mean Squares	F-value
Error	193	1660.62	8.60	
Gender	1	65.79	65.79	7.65*
Course	3	58.62	19.54	2.27
Gender(G) *Course (C)	3	38.48	12.83	1.49
Grade Level(GL)	3	69.76	23.25	2.70*
G*GL	3	46.80	15.60	1.81
C*GL	7	102.28	14.61	1.70
G*C*GL	7	39.66	5.67	0.66

*$p < 0.05$

The interaction, gender-by-mathematics course-by-grade level indicated that students' negative attitude toward mathematics did not differ regardless of gender, course, or grade level. However, statistical significance was revealed for gender with an F-value of 7.65 and $p < 0.05$. The female students' mean score for negative attitude was greater than the male's mean score (see Table 3). Although this result is significant, the reader should be cautioned that the significance is due to the large sample size since three percent of the variance is attributed to gender differences. There was a grade level significance with an F-value of 2.70 and $p < 0.05$ that barely met the requirements for significance. Students differed slightly in negative attitudes toward mathematics in various grade levels.

Table 8 presents the Three-way ANOVA for Traditional Activities. There were no interactions that were significant. However, the variables, gender and mathematics course, produced statistically significant results with respective F-values of 7.80 and 3.09 and $p < 0.05$. This indicated that the males and females tended to view traditional mathematics classroom activities differently from one another. A post hoc Tukey Studentized Range Test revealed that students in Calculus were experiencing more frequently traditional mathematics classroom activities than students in Algebra I.

Table 8

Three-Way ANOVA for Traditional Mathematics Classroom Activities

Source of Variation	df	Sum of Squares	Mean Squares	F-value
Error	187	4355.18	23.29	
Gender	1	181.74	181.74	7.80*
Course	3	215.97	71.99	3.09*
Gender (G) *Course (C)	3	44.44	14.81	0.64
Grade Level(GL)	3	10.02	3.34	0.14
G*GL	3	145.62	48.54	2.08
C*GL	7	62.10	8.87	0.38
G*C*GL	7	130.61	18.66	0.80

*$p < 0.05$

However, there was not a statistical difference for the non traditional activities. This indicated that the students regardless of their gender, mathematics course, or grade level saw similar occurrences regarding the non traditional classroom activities. The interactions were also non significant.

Student Achievement.

Various achievement indicators such as TAAS scores, final course grades, and first and second semester grades were correlated with the major subscales from the student survey, positive attitude, negative attitude, traditional activities, and nontraditional activities. Table 9 presents the Correlation results.

Table 9

Pearson Correlation Coefficients for Achievement and Student Survey Subscales.

	TAAS	8th First Semester	8th Sec. Semester	Positive Attitude.	Negative Attitude	Trad. Activities	Nontrad.
Final	-0.21966 N = 38	0.02649 N = 13	0.12009 N = 13	0.43615** N = 156	0.13775 N = 154	0.18221* N = 150	-0.01921 N = 152
TAAS	1.00	0.58375* N = 14	0.23332 N = 14	-0.16626 N = 51	-0.15679 N = 52	-0.01974 N = 51	-0.09264 N = 52
First		1.00	0.49082 N = 15	-0.26738 N = 15	-0.01163 N = 15	-0.30011 N = 14	-0.49887 N = 15
Second			1.00	0.04765 N = 15	-0.17956 N = 15	-0.09839 N = 14	-0.12658 N = 15
Positive				1.00	0.22631** N = 216	0.3208** N = 211	0.29390** N = 215
Negative					1.00	0.27572** N =211	0.16651* N = 216
Trad.						1.00	0.12502 N = 216
NonTrad.							1.00

*p < 0.05
**p < 0.0001

The final course grade in high school mathematics was negatively correlated with the TAAS score. This indicated that the students who had high averages scored lower on the TAAS. The result may be due to the small sample size. A positive correlation was with positive attitudes. Student with higher final course grades had more of a positive attitude toward mathematics. There was a statistically significant correlation of the final course grade with traditional activities although it was a low correlation.

The eighth grade TAAS score correlated highly with the eighth grade first semester grade. The students who had a high average scored higher on the TAAS. Similarly, there was a strong correlation between the eighth grade first and second semester grades; the students who had high first semester averages tended to have high second semester averages in mathematics. A strong positive attitude correlated with both traditional and non traditional activities. The result suggests that students maintained a positive outlook toward mathematics regardless of the type of activities. However, this may be due to the fact that the students typically encountered traditional classroom activities more often. However, students tended to have a better attitude toward mathematics when more nontraditional activities were employed. This is indicated by the correlation coefficient between negative attitude of 0.16651 with nontraditional activities and positive attitude correlation coefficient of 0.29390 with nontraditional activities.

Interviews. Ten students were interviewed using a semi-structured format. There were core questions, but the interviewer had the flexibility to lead the interview into a direction that he/she felt would be productive. During the transcription process, it was revealed that there were some difficulties in the interviews' audio taping process such as background noise due to limited facilities for conducting the interviews in a quiet place. In order to protect anonymity, the students' first name and initials are used for identification. Hence, some of interviews were difficult to transcribe. The following is a summary of the interviews.

Students. Generally, the students could not define mathematics. It seemed that this may have been the first time students were asked to actually think about what is mathematics. Typical responses to this question included, "I don't know," or "numbers." Pedro was an exception. He viewed mathematics "as a science," rather hesitantly, he continued by saying, "it helps in science, like in Biology, for like for example, uhm, in converting like in converting like uhm from well when we use uh, the different uh, what are they called, the measuring system." Pedro appeared to be aware that mathematics is useful in science but had difficulty conceptualizing its usefulness in some detail. To him, mathematics use was a way to convert units with little understanding in how the units were related.

An Algebra II GT student, JDL, suggested that "mathematics is the study of numbers and how you use them and the way that they are helpful." This student's definition implies that he/she understands that mathematics has a practical side, but it is not fully realized. The student could not give an example, and does not like problem solving, in fact he/she said, "I don't like problem solving."

The dislike toward problem solving was typical among the students. When asked do you like problem solving, JJ responded, "No, not at all!" After further probing, JJ revealed, however, that he does get the word problems right on tests. The student revealed his/her technique, "I read the problem five times, determine an equation, then I try to figure out what type of problem it is, substitution problem, slope, and figure it out." Another student, DG said, "Problem solving? its [. . .] just trying to get the answer step by step." DG's response indicated that she viewed problem solving as a procedural process. Conceptual understanding within problem solving seems lacking in the students. These responses suggested that the student has encounter problem solving in lock step following particular sections from the textbook rather than gaining a holistic view of problem solving. Similarly, in regard to reading the problem several times, JG said, "What you read, like, you have to understand it, so you can work the problem." the student's response indicated that reading comprehension is important to his/her success at problem solving. It appears that problem solving is not greatly emphasized in the students' classes regardless of the course.

Similarly, students typically could not provide an example of how mathematics relates to real life. The students' responses indicated that the teacher uses the idea that mathematics is useful but fail to have the students internalize the notion through actual examples. AL, an Algebra II student, mentioned, "When you're going to the store, if your taking the SATs." It appeared that applications of mathematics is used very little to explain concepts.

In relation to classroom activities, the students typically mentioned that the teacher lectures, "some are boring, and some are not," and they work on a lot of worksheets and textbook problems. Al was asked about this and responded, "she assigns them (worksheets) like, every night." The interviewer asked, "Does she use the textbook sometimes?" Al said, "yeah." The interviewer asked, "For homework? About how many problems do you do?" Al responded, "Like 30 or 40 problems a night." Edith when asked the same question said worksheets are assigned "everyday."

In reference to TAAS preparation worksheets, most students did not think that the emphasis or frequency of their use was too much. This may be due to the fact that since they may be an integral part of their mathematics experience that it is difficult to distinguish the difference. The author was on site for a year, and on each occasion, when he entered the copy room, there were stacks of worksheets, and adjacent to those stacks were TAAS practice worksheets. One student, Pedro, was straight forward when asked the question concerning the TAAS practice sheet. He said, "Well, yeah, 'cause uhm, I don't know, like, like, I feel like we get like pressure too much with the TAAS and, all we do is like get trained just, just to do the, the TAAS test and I like, like we learn, like a sort of training to pass the test." The interviewer asked, "You would like to learn more mathematics?" Pedro said, "Yeah, and not just like what they teach us just for the particular test, more about the subject." Pedro clearly identifies his frustrations concerning this emphasis. He also implies that he feels that he is not really learning mathematical concepts.

Calculators were mentioned by the students as a tool used in making fast calculations. This was indicated by GL who said, "Uh, huh, its mainly, we understand what's going on, the calculator's just an instrument to help us go faster, and speed the practice up instead of, having to multiply everything in you head, just type it in." In another interview, the interviewer said, "So, you use the calculator but not in problem solving." The student, AL, said, "Sometimes, the calculator doesn't give you the answer you want and you have to figure out the long way, you have to figure it out on paper." It appeared that calculators are conceived as a device to aide in getting answers, rather than as a tool to develop conceptual/procedural understanding. It is used strictly for calculations, to get things done quicker.

The students overwhelmingly indicated that they feel comfortable to ask questions in class. The responses were very positive and they have admiration for the teachers. It appeared that the students like "cooperative learning." From the responses, cooperative learning occurred as peer tutoring. One student's typical response was, "If I don't understand it, they [other students] can help me. Reciprocity appeared to be highly valued by the students through the continuation of the student's response, "so when they don't understand it, I help them, and if I don't understand it, they help me." The students feel comfortable in class. The teachers display positive attitudes toward the students. The students do not feel threaten if they have a question; the teachers are viewed by the students as very helpful.

Discussion and Conclusion

Since this preliminary study was conducted at one high school, one must caution against the generalization of the results to a larger population. However, the findings are illuminating and provide a glimpse of how students viewed mathematics. This study revealed that student attitudes toward mathematics were not very favorable and differences in attitudes were found among gender groups and courses. Some of the results are similar to the findings of other researchers, for example, by Schoenfeld (1989) that mathematics problems can be solved quickly, Underhill's (1988) finding that mathematics is rule-oriented and information is transmitted, and Thorndike-Christ's (1991) result that students in accelerated "tracks" have more positive attitudes. It appeared that the algebra and geometry students' poor attitude toward mathematics may be blocking access to upper high school mathematics classes.

Overall, the students were not very enthusiastic about mathematics. Both genders held equally poor attitudes toward mathematics. However, there was a difference between male and female students in the degree of negative attitudes toward mathematics even though both genders held unfavorable attitudes toward mathematics. The female Hispanic students held more negative attitudes toward mathematics than the male Hispanic students. This finding is contrary to the Thorndike-Christ (1991) study that noted female students' attitudes were generally positive toward mathematics.

It appeared that the female students sought to reach a high level of achievement in mathematics despite their poor attitudes. This was evident by the female students who indicated a greater frequency than male students of showing their work on tests and quizzes. In conjunction with a negative attitude, the female Hispanic students' perceived a greater frequency of traditional teaching activities than the male students. This may be an indication that although the female students are generally negative toward mathematics classes, they are willing to work at mathematics. The female students also reported working with others more often than male students on mathematics related tasks. This suggests that female Hispanic students prefer to work cooperatively on mathematics tasks. The female students' willingness to "work harder" and their affinity for completing tasks with others may be due to a lack of, or low a level of self-confidence. Further study would be necessary to examine Hispanic female students' confidence level. The female students appeared to "pay more attention" as evident by a greater frequency of watching the teacher work problems on the board, and they approach the teacher more often than the male students about their progress. Consequently, despite their poor attitude toward mathematics, the female Hispanic students at this school are striving to be successful in their classes.

It appears that the students viewed their course work in mathematics as something that they have to do and do not enjoy doing mathematics, with the exception of the calculus students. Attitudes toward mathematics varied from course to course. This result could be related to either the course itself, or to the teacher who taught the course. In particular, the students in both Algebra I and II, had poor attitudes toward mathematics. A surprising result was found in the calculus classes. Although pre-calculus and calculus students reported a greater frequency of traditional activities, the students held a more positive attitude toward mathematics than students in the other course categories. This lends support to the view that when students reach calculus, the students enjoy mathematics although it is presented in a formalist classroom devoid of student-centered activities. It appears that the calculus students, who showed positive attitudes toward mathematics, have been successful in a formalist classroom, and they are more adept at a traditional approach to mathematics learning.

Student achievement data when correlated with the survey subscales revealed a positive correlation between the final course grade and positive attitudes. This lends support to the idea that student who hold a more favorable outlook toward mathematics tend to have higher achievement levels. A surprising result was the nearly equal correlation coefficients associated with both the traditional and nontradtional activities, and positive attitude variables. This alarming result suggests that regardless of what type of activities the students encounter, their positive attitudes would be unaffected. This indicates that the students harbored strong negative attitudes toward mathematics and that perhaps even a student-centered classroom would not influence a change in attitude. Despite this obstacle, it is recommended that activities should be developed to foster greater intrinsic value of mathematics.

Clearly, the classroom activities data revealed that the students experienced a teacher-centered, "school mathematics tradition." The finding was evident by the higher frequency means for the traditional activities like watching the teacher do problems on the board, or completing worksheets alone at their desks. However, students had opportunities to work with other students, and they found this of great value. The interview summary revealed that students really enjoy working with one another. The high frequency of worksheet completion may be due to the stress placed on mastering the skills to pass the TAAS test, or that teachers are reluctant to try other approaches like projects or hands on activities. Students use calculators fairly often, but they are used for calculating rather than for learning concepts. The calculus students used calculators more often than students in the other courses. An interpretation of this suggests a teaching philosophy that before students are permitted to use calculators, they should master the basic skills. Traditional assessment practices occurred through tests and quizzes. Projects were seldom employed for either instruction or assessment by the teachers. This would indicate a need to infuse authentic assessment strategies to improve attitudes. Telese (1993) found that student attitudes toward mathematics improve when authentic assessment techniques are used in the classroom.

The disturbingly poor attitudes toward mathematics indicated by the algebra and geometry students raises a cautionary flag. If algebra is considered a gatekeeper, then it becomes imperative that teachers, parents, counselors and other people in authority emphasize the importance of obtaining algebraic knowledge and provide activities meant to increase motivation and improve attitudes. This study revealed that students in the lower layers of mathematics curriculum harbor unfavorable attitudes towards mathematics. This, as the NACME (1995) study suggests, may cause students to stop taking mathematics classes as early as possible. However, when students continue upward through the layers reaching pre-calculus or calculus, then their attitudes become more favorable. Yet many students are lost along the way, evident by low enrollment numbers in high school calculus courses.

Greater efforts should be placed on making the algebra and geometry curricula more meaningful and relevant to the students' social context. Mathematics when viewed in this light implies that it should be studied in a manner that capitalizes on students' language, cultures, everyday lives, and school-based experiences (Romberg & Spence, 1995). Teachers should begin to adopt the Growth and Change view of mathematics in order that a greater number of students begin to see that mathematics is interesting, relative to their lives, and that discoveries are being made in mathematics; it is not a static discipline. The Hispanic students at this school appeared to encounter the stereotypical mathematics classroom which is appealing for some students (i.e., calculus students), but not for a majority of students. The Hispanic students surveyed indicated that mathematics was viewed as being unrelated to their lives, but useful. The NACME (1995) study indicated that the lack of encouragement from significant others, with the exception of their classroom teachers, creates a tendency for Hispanic students to drop mathematics courses as soon as they can, thus deselecting themselves from the mathematics pipeline of rewarding careers in the sciences. Is this a reaction as a result of viewing mathematics in an unfavorable light?

Mathematical literacy is a necessary trait for individuals to possess for success in the 21st century. Algebra as the "new civil right" entitles students to the full benefits offered by possessing algebraic knowledge. This goal is difficult to achieve when many students harbor negative attitudes towards mathematics. The solution is a complex one involving the whole community (Lacampagne, Blair, & Kaput, 1995). A first step is to begin the changes in the classroom, offer professional development opportunities for teachers, and inform counselors and parents of the value that is placed on mathematical knowledge.

Further research on Hispanic students attitudes includes a process to probe further their expectations, career aspirations and delineated some socio-cultural factors associated with success and failure to progress through the pipeline. Another area for research is to focus classroom observations of students that reveal their attitude toward mathematics and describes the social context of the classroom. The result of the study raised more questions. What changes in attitude occur as a result of experiencing classroom activities that are relevant and meaningful to Hispanic students' lives? To what extent do these activities encourage student participation? How are attitudes and beliefs affected when problems are identified and solved within their social context using mathematical knowledge, i.e., algebraic knowledge? To what extent will cooperative learning improve female Hispanic students' attitudes toward mathematics? What characteristics are possessed by students who are succeeding (i.e., good attitudes in upper level classes)?

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Organization/Address: University of Texas, Brownsville, School of Education, 80 Fort Brown, Brownsville, TX 78520

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