SIGN ME UP!

DETERMINING MOTIVATION FOR HIGH SCHOOL CHEMISTRY STUDENTS ENROLLING IN A SECOND YEAR CHEMISTRY COURSE

A Thesis

By

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ABSTRACT

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A sample of 108 Pre-AP Chemistry students in Texas participated in a study to determine motivational factors for enrolling in AP Chemistry and University Chemistry. The factors measured were academic attitude, perceptions of chemistry, confidence level in chemistry, and expectations/experiences in the chemistry class. Students completed two questionnaires, one at the beginning of the year and one at the end. Four high school campuses from two school districts in Texas participated. Two campuses were traditional high schools and two were smaller magnet schools.

The results from this study are able to confirm that there are definite correlations between academic attitudes, perceptions, confidence level, and experiences and a student's plans to enroll in AP and University Chemistry. The type of school as well as the student's gender seemed to have an influence on a student's plan to enroll in a second year of chemistry.

DEDICATION

First, and foremost, I would like to give all honor and glory to God for giving me the courage and strength to complete this work. It is by His might and His power that all things are made possible.

I would like to dedicate this work to my loving family in gratitude for the support and understanding that has been demonstrated during my years of graduate study. Thank you, Mom and Dad, for being a living example of what it means to have faith in God, love for family, and a strong work ethic. The legacy you have built will remain for generations. Loving appreciation also goes out to my husband, without whose support, this endeavor would have been impossible. Thank you also to my son and daughter for your unconditional love and words of encouragement. I hope that you and your sister's achievements will surpass mine. You both bring me joy.

I would also like to give special thanks to the hundreds of students that I have had the privilege of working with during my career. You inspire me to be a better teacher and my hope is that this work will help other teachers like me strive for that goal.

TABLE OF CONTENTS

LIST OF TABLES

Page

CHAPTER I

INTRODUCTION

It is believed that as a result of their high school chemistry learning experiences, students develop attitudes toward chemistry and perceptions about their capacity to do chemistry, known as self-efficacy, which they bring with them to college (Dalgety, Coll, & Jones, 2003). Furthermore, it is suggested that these beliefs have a correlation to academic performance in college (Choi, 2005). The implications are that students' learning experiences coupled with their attitudes and perceived self-efficacy subsequently affect decisions to enroll in further chemistry courses. In this study, high school chemistry students and teachers from South Texas were surveyed regarding the students' learning experiences, perceptions of chemistry, and chemistry self-efficacy to determine how these factors affected their motivation to continue their study of chemistry.

Science in High School

In the 1930s, the National Educational Association established and commissioned the Committee of Ten (CoT) to develop a suggested course sequence for science. They decided that Chemistry should be taught after Biology and before Physics. Along with this sequence of science courses, the CoT and its subcommittees recommended that high school chemistry should be a part of college entrance requirements and made suggestions as to what the high school courses should entail to create uniformity across the U.S. (Sheppard & Robbins, 2006).

Consequently, national education standards were developed and Texas's state education standards followed. It is from here that Texas high school graduation requirements were put in place. However, at this time chemistry was not a required course and often only those interested in pursuing careers in science and technology were taking chemistry. In 1980, the National Science Foundation reported that only about one sixth of students were taking courses past tenth-grade biology and that very few were female or minority students (Crawley & Koballa, 1991).

Research has continued to influence the education standards and consequently the graduation requirements also have changed, but chemistry has remained as a suggested course for college bound students. In Texas until recently, however, only those students following the Texas Recommended Graduation Plan or higher were required to take high school chemistry. These students were often deemed by teachers and academic counselors as those that were college bound. Students on the Texas Minimum Graduation Plan often only took Biology and a general physical science course.

However, there was a change in the high school graduation requirements for those Texas high school students beginning ninth grade in the 2007-2008 school year. Now, all students must complete four years of science, with chemistry being one of the required courses (Tex. Admin. Code, 2007). Currently, a typical high school student may take biology, Integrated Physics and Chemistry (IPC), chemistry, and physics, with either biology first or IPC first. Some students that are in more advanced studies may choose to forego IPC and take an elective science course, such as Anatomy and Physiology or an Advanced Placement (AP) course, their senior year. Students may choose from AP Chemistry, AP Biology, and/or AP Physics, to prepare them to take the AP exam in that area of study. Although high school chemistry teachers will use various teaching techniques and strategies, the fact is that all students

graduating from high schools in Texas in 2011 or later and entering a college will have had some form of high school chemistry instruction.

Questions to Consider

What factors lead to high school students choosing to enroll in AP Chemistry? How do learning experiences affect the formation of attitudes toward chemistry and chemistry self-efficacy? How are students' learning experiences, attitudes, and self-efficacy related to their enrollment choice for AP Chemistry? Answering these questions would provide insight as to some conditions that have predictability for AP Chemistry enrollment.

While it is hypothesized that students that have positive attitudes toward chemistry and high chemistry self-efficacy (confidence) would be more motivated to enroll in AP Chemistry, it is believed that many students are leaving introductory chemistry courses with low chemistry self-efficacy and negative attitudes. Surveying high school students that would be good academic candidates for AP Chemistry, namely those enrolled in a Pre-AP Chemistry courses, could provide information about what types of classroom learning experiences are responsible for creating the desired chemistry attitudes and self-efficacy beliefs. Teachers may then be able to discern which practices are the best to increase enrollment in more chemistry courses. This could also lead to methods to rejuvenate interest in chemistry as a course of study as well as a career choice which could, in turn, increase the number of skilled chemists in the workforce.

CHAPTER II

LITERATURE REVIEW

Recently, there has been a national as well as international focus on science education. Some literature suggests that the conditions of science education are in a critical state (Venville, 2008; Crawley & Koballa, 1991). Professor Russell Tytler (2007) delineates the reasons for this calamity.

> *There are four main elements to the crisis in science education:*
> - *evidence of students developing increasingly negative attitudes to science over the secondary school years*
> - *decreasing participation in post-compulsory science subjects, especially the 'enabling' sciences of physics and chemistry, and higher mathematics*
> - *a shortage of science-qualified people in the skilled workforce*
> - *a shortage of qualified science teachers*

In addition to the negative attitudes towards science, reports from American College Testing (ACT, 2003) indicate that although standardized test scores had increased over the previous years, "math and science preparation appears to be weak" (Tai, Sadler, & Loehr, 2005). Crawley and Koballa also confirm that there is a problem of fewer people entering science related professions (1991). Perhaps the decrease in participation in more advanced science and math courses can be attributed to the students' attitude and lack of science skills. Another idea suggested by Mangrubang (2005) is that the weaker science skills and increased negative attitude that students are demonstrating are simply a result of the lack of adequate teacher preparation and decreased teacher job satisfaction, some reasons that teachers are leaving the profession

early. It seems that the cycle of blame could go on and on, but it is clear that a problem exists and this is why many are looking for reform in science education.

Determining what makes students successful has encompassed a wide range of studies in general education as well as chemistry education. For many years, chemistry education research has sought to understand the effect that high school chemistry courses have on college chemistry enrollment (Murno & Elsom, 2000) and achievement. The literature suggests a wide range of predictors of student performance in chemistry, including demographic and educational factors as well as high school experiential factors (Tai, Sadler, & Mintzes, 2006). Tai, Sadler, and Loehr (2005) propose that students' high school learning experiences are an important contributing factor to success in college. Since educators have little control over the demographic factors, such as race and highest parental educational level, it is those educational and experiential factors that should be focused on, for example the last high school grade in science, enrollment in AP science courses, and the number of laboratory activities in science courses.

Much research has been done to analyze these experiential factors and how they motivate students to study science. Some studies consider hands on classroom laboratory activities a useful method of increasing motivation (Ornetein, 2006). Others have gone further, imploring others to see the benefits of high school students participating in scientific research (Carriere & Abouaf, 1997). Without these experiences, some students report that there is a "lack of perceived relevance of the content of the curriculum," which lowers the motivation of many students to continue studying science (Driel, 2005).

One other factor that is being studied because of its impact on success and motivation is chemistry self-efficacy. It has been reported that attitude toward chemistry and chemistry self-efficacy change as a result of a student's high school learning experiences (Dalgety, Coll, &

Jones, 2003). Such experiences may consequently influence student decisions about enrolling in AP Chemistry courses as well as college level chemistry courses. It may even have an impact on their college major. Before we consider some studies that have looked into the topic of student attitude toward chemistry and chemistry self-efficacy, however, it is important to clarify the definition of self-efficacy. Dalgety, Coll, and Jones (2003) define self-efficacy as the students' "perception of his ability to undertake a specific task." This definition is based on the work of Albert Bandura (1986), a leading psychologist in the area of social cognitive theory and self-efficacy.

Learning experiences as well as attitude are related to self-efficacy. For example, if a student thinks that she has limited capability for problem solving, then she may transfer that low self-concept to a laboratory activity where problem solving is necessary. This student may consequently develop an attitude regarding the difficult nature of chemistry. In this case, attitude can be defined as "a mental and neutral state of readiness, organized through experience, exerting a directive and dynamic influence upon the individuals' response to all objects and situations with which it is related" (Dalgety, Coll, & Jones, 2003). Later when this same student is placed in a different chemistry learning experience where problem solving is not directly involved, the student may decide that it is too difficult before even attempting the activity.

There are only a few studies about the learning experiences of first year chemistry students (Dalgety & Coll, 2003; Tai, Sadler, & Mintzes, 2006), and even fewer on the learning experiences of high school chemistry students (Murno & Elsom, 2000). Some correlations have been suggested, however, that because math is involved in chemistry problem solving, students bring those attitudes and self-efficacies towards math into the chemistry class creating what has been termed "chemophobia" (Eddy, 2000). This study suggests that anxiety towards chemistry

has many roots in math anxiety although a little is related to trait anxiety. Some of the anxiety, however, is strictly due to chemistry. When students feel these levels of anxiety, their performance may be affected (Eddy, 2000) and in turn their attitude toward chemistry and chemistry self-efficacy are affected.

Several instruments have been used to measure student attitude toward science. The Chemistry Attitudes and Experiences Questionnaire (CAEQ) (Dalgety, Coll, & Jones, 2003) and the Chemistry Self-Concept Inventory (CSCI) (Bauer, 2005) are two examples. According to Dalgety, the Test of Science Related Attitudes (TOSRA) developed in 1981 by Barry Fraser and the Scientific Attitudes Inventory II (SAI II) were the main instruments used to develop the CAEQ, while Bauer states that the CSCI was developed from the Self Description Questionnaire III (SDQIII). Although all instruments reported strong validity and reliability characteristics, some reports have criticized these types of instruments, questioning the construct validity of these instruments (Dalgety, Coll, & Jones, 2003), especially in the areas of theoretical framework and pilot testing. Construct validity is important because it measures whether your questions measure what you want them to measure. More recent instruments, such as the CAEQ, have taken heed to the criticisms and sought to improve the construct validity.

CHAPTER III

METHODS AND INSTRUMENTS

The objectives of this study were to understand the learning experiences of high school chemistry students in their first chemistry course. Data was obtained in four main areas: attitude, confidence, experiences in chemistry, and plans to enroll in further chemistry courses. Quantitative data was obtained using the previously validated Chemistry Attitudes and Experiences Questionnaire (CAEQ) (Dalgety et al., 2003) and some additional questions about intent to enroll in further chemistry courses. Students were also able to contribute additional information via open-ended questions at the end of each section. Both quantitative and qualitative findings were used to gain in-depth understanding of students' intent to continue studying chemistry and factors that affect their decision.

Context

The sample population in this study consisted of a group of 108 Pre-AP Chemistry students from two school districts including students from across the four counties of the Rio Grande Valley in deep, south Texas. The school districts are very different from each other. The first school district, here in referred to as ISD1, services approximately 2,500 students in four high schools. The second school district, here in referred to as ISD2, services approximately 4,500 students in its two high schools. Five chemistry teachers from five different high schools in the two participating school districts were recruited by the beginning of August 2009 using

email (Appendix A). Two other school districts, each with three high schools, were invited to participate; however, permission was not granted in time for the beginning of the study.

Each of the five participating schools is a public high school. Three of the schools are from ISD1 and two are from ISD2. The two schools in ISD2 are more traditional public high schools with classes meeting every day for 55 minute class periods and an athletic program. These are larger high schools with enrollments of more than 2000 students each. The schools in ISD2 will here in be referred to as Schools 1 and 2. The three high schools in ISD1 are magnet schools that do not offer athletic programs but rather uniquely specialized areas of study in addition to the regular high school curriculum. These magnet high schools each provide one or more distinctive tracks of study, such as medical, science, or engineering, and students take elective courses based on their track. The magnet high schools have enrollments between 500 to 700 students each. One of the campuses, here in referred to as School 3, teaches in an accelerated block setting in which students complete the chemistry credit in one semester meeting every day for 90 min each day. Two of the campuses, here in referred to as School 4 and 5, teach in an alternating block schedule where the students meet for 90 min every other day.

Survey Administration

The teachers that participated were Pre-AP Chemistry teachers and selected two or more of their classes to collect data for the study. The goal was to include at least 50 students from each campus to answer two student survey questionnaires. Each chemistry teacher completed the teacher informed consent form and the teacher survey (Appendix A). In the teacher survey, each chemistry teacher answered questions about their teaching experience and preferences as well as their teaching style. Table 1 below details the information provided by the teachers. Although, more were invited, only one teacher from each school participated in the study.

Within the first few weeks of school, the teacher chose which Pre-AP Chemistry classes to invite to participate in this study. To be eligible, student participants had to be enrolled in Pre-AP Chemistry for the first time. Table 1 below shows the student demographics.

Table 1: Teacher Experience

School	Teaching experience (years)	Years with district	Courses taught	Common practices and strategies
1	4	4	Chemistry Pre-AP Chemistry	Lectures, Discussions, Learning Groups, Lab experiences, Inquiry lessons, Concept maps.
2	5	5	Chemistry Pre-AP Chemistry AP Chemistry	Lectures, Lab experiences, Lab demos, Discussions, Learning groups, Mutli-media presentations
4	20	6	Chemistry Pre-AP Chemistry AP Chemistry Integrated Physics and Chemistry	Discussions, Lab experiences, Lab demos, Critical thinking skill building.
5	4	4	Chemistry Pre-AP Chemistry	Discussions, cooperative learning groups, lab experiences, lab demos, inquiry lessons, Cornell notes

Table 2: Student Demographics

School	Female	Male	9th grade	10th grade	11th grade	12th grade	totals
1	30	18	0	48	0	0	48
2	11	6	0	17	0	0	17
4	17	8	1	22	2	0	25
5	11	7	1	17	0	0	18
Total sample	69	39	2	104	2	0	n=108

A total of 108 students participated in the study by answering a pre-course and post-course questionnaire. The demographics of the students that participated are shown in Table 2. More detail about the questionnaires will be discussed later in this section.

Parent and student informed consent forms were distributed to all eligible students (Appendix A). In order to participate, students had to return the parent and student consent forms in a timely manner. This would ensure that student participants would complete the Participant Information (Appendix A) sheet and Questionnaire 1 (see Appendix A) prior to the first grading period of the course. The purpose of this time frame was to give a more accurate picture of the students' initial attitudes, perceptions, confidence level and expectations.

Questionnaire 1 (Q1) attained student demographic information such as gender, ethnicity, and each student's science background. The Q1 also assessed students' general attitudes toward academic courses, their initial perceptions about chemistry and chemistry related things, their confidence level, and finally the students' expectations about the course. Questionnaire 2 (Q2, see Appendix A) was a comparative survey that would be administered within the last quarter of the course to indicate how the students' views had changed if at all. The second survey was sent out to the campuses in late February and participating teachers were asked to complete the survey in the month of March. Since School 3 had already completed the course by this time, and the students were no longer enrolled in Pre-AP Chemistry, these students did not participate in the Q2 administration. Since there are many high stakes tests given during the last six weeks of school (TAKS, AP exams, EOC, & semester exams), it was important to administer Q2 before any of these testing dates so not to interfere with these exams or compromise the integrity of the survey itself by having teachers hurriedly administer the questionnaires.

Most of Q1 and Q2 were identical, with the exception of the experiences portion. At the onset of the school year students were be asked for their expectations rather than their experiences since they would not yet have experienced all aspects of the course. Each question, however, was worded in an almost identical manner. Also, the breakdown of each section and question was almost identical for both Q1 and Q2 with the major difference being that only Q1 had the student demographic questions at the beginning of the questionnaire.

The first question set in both surveys asked the students about their general attitudes toward school. This section used a five point rating scale where students responded to a series of statements with their level of agreement or disagreement to answer 11 questions. In the rating scales used in this question set, a score of 5 reflects the most positive or desirable response. Three questions had wordings that were reversed. For example one statement read, "I enjoy doing work for most academic subjects." While another read, "I hate studying most academic subjects." For the latter statement, the wording is reversed to make sure students are actually reading the questions and not just randomly selecting responses. A student that agreed with the first statement would most likely disagree with the reverse worded statement.

The second question set used a seven point semantic differential scale to consider the student's perceptions on chemists, chemistry jobs, and assess leisure interest in chemistry. There were a total of 22 questions in this section and a score of 7 was assigned to the most positive perception for each question. There were three questions included in this section involving negative perceptions of chemists or chemistry to make sure that the students were in fact reading all of the questions and responding consistently.

The third question set considered confidence level or chemistry self-efficacy and had 19 questions using a similar five point rating scale to the one mentioned earlier. This question set included questions about problem solving as well as laboratory work.

The fourth question set contained the learning expectations and experiences component. In Q1 the learning expectations were considered. In Q2 the learning experiences were considered. The wording was only slightly changed between Q1 and Q2. Twenty-four questions using a five point rating scale were used for this last section that considered lecture, lab, and tutorial aspects of the course.

In both questionnaires, students were given room to elaborate on their perceptions, confidence level, and experiences/expectations. In addition, both Q1 and Q2 inquired about the students' plans to enroll in AP Chemistry and University Chemistry to see if any changes occurred from the beginning of the course to the end of the course. Lastly, students were asked to predict their grade in the course.

The instrument used in Q1 and Q2 is closely modeled after the CAEQ because of its theoretical framework and predictability; however, some questions were reworded to make it clearer for this group of high school students. The CAEQ was developed to assess first year college chemistry students therefore modifications had to be made because the structure of the courses is different, with laboratory, tutorial and lecture taught together by the same teacher at the high school level and separately at the college level, often by different instructors. Also, the open ended questions were added to probe further into the students' specific reasoning rather than the interview aspect that was used by Dalgety in the CAEQ.

Data Analysis

Once the surveys were completed and returned, the data was transcribed to Excel and then imported to SPSS 17.0 for statistical analyses. Descriptive and comparative analyses were conducted. One-way ANOVA was used for the comparative analyses using factors such as gender, school, plan to enroll in AP Chemistry, as well as plan to enroll in University Chemistry to analyze the attitudes, perceptions, confidence levels, and expectations/experiences of the students. Tukey Post Hoc analyses were used for multiple comparisons and statistical significance was set to $p = 0.05$. In addition, the comments recorded by students were also transcribed to the Excel document for examination. Furthermore, student responses that did not consist of both questionnaires were not included in the analysis. This left 108 students responding to both questionnaires. Demographics of the student sample are described in Table 2. Responses with missing values were excluded on a case by case basis. Although the questionnaire included other demographic information, such as ethnicity, these were not chosen as factors to consider at this time.

CHAPTER IV

RESULTS AND DISCUSSION

Since the focus of the study lies in what factors contribute to student enrollment in further chemistry courses, the results are organized accordingly by plans to enroll in AP Chemistry and by plans to enroll in University Chemistry. The factor analysis of the data was conducted considering the choices to enroll in AP Chemistry as well as University Chemistry courses compared with students' academic attitudes, perceptions, confidence, and experiences. Relationships between these four factors and gender are also considered.

Academic Attitudes

To assess student attitudes towards academics, an eleven question set was used. Students decided how accurately the questions described their academic attitudes using a 5 point Likert scale, where 5 was totally accurate and 1 was not accurate at all. Also three questions, numbers 2, 5 and 8, were reverse worded to make sure students were reading the questions and answering accordingly. Tables 3 and 4, below, show the results of the factor analysis of the student's academic attitude compared to their plans to enroll in AP Chemistry (Table 3) and University Chemistry (Table 4). It is important to note that these data tables and the other data tables in this section only show those results that had statistically significant differences at the p=0.05 level. The complete data set is available in Appendix B.

Table 3: Factor Analysis of Academic Attitudes and plans to enroll in AP Chemistry

	Question	Enroll in AP Chemistry	Mean Q1	Mean Q2
1	I have a lot of intellectual curiosity.	Yes	4.13[b]	4.00
		No	3.64	4.10
		Undecided	3.58[b]	3.69
2	I'm not particularly interested in most academic subjects.	Yes	2.11[b]	2.21
		No	2.36	2.60
		Undecided	2.79 [b]	2.73
9	I can often see better ways of doing routine tasks.	Yes	3.46	3.68[b]
		No	2.82	3.35
		Undecided	3.36	3.22[b]
11	I plan to pursue a course of study in college where knowledge of chemistry is beneficial.	Yes	3.48	3.88[a,b]
		No	2.82	2.50[a]
		Undecided	2.84	2.93[b]
	Overall means for academic attitudes (reversing questions 2, 5 and 8)	Yes	3.47	3.44
		No	3.06	3.07
		Undecided	3.08	3.13

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.

Table 4: Factor Analysis of Student Academic Attitudes and plans to enroll in University Chemistry

	Question	Enroll in University Chemistry	Mean Q1	Mean Q2
1	I have a lot of intellectual curiosity.	Yes	4.14[a]	3.98
		No	3.14[a,c]	3.81
		Undecided	3.89[c]	3.83
2	I'm not particularly interested in most academic subjects.	Yes	1.79[a,b]	2.49
		No	3.07[a]	2.38
		Undecided	2.55[b]	2.56
3	I am good at combining ideas in ways that others have not tried.	Yes	3.30	3.55[a]
		No	2.93	2.69[a]
		Undecided	3.13	3.31
5	I hate studying many academic subjects.	Yes	2.36[a,b]	2.56[a,b]
		No	3.50[a]	3.44[a]
		Undecided	3.03[b]	3.23[b]
10	I enjoy doing work for most academic subjects.	Yes	3.36[a,b]	3.07
		No	2.43[a]	2.50
		Undecided	2.83[b]	2.83
11	I plan to pursue a course of study in college where knowledge of chemistry is beneficial.	Yes	3.93[a,b]	4.14[a,b]
		No	2.29[a]	1.75[a]
		Undecided	2.97[b]	2.96[b]
	Overall means for academic attitudes (reversing questions 2, 5 and 8)	Yes	3.55	3.45
		No	2.81	2.90
		Undecided	3.24	3.17

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.
[c] The mean difference between no and undecided is significant at the p = 0.05 level

It is notable, that students report that they are more likely to enroll in an AP Chemistry or University Chemistry course if they feel that knowledge of chemistry will be beneficial to their course of study in college. See question 11 in both Table 3 and Table 4. For AP Chemistry, this was more evident in Q2, once students had completed most of their first year of chemistry. Students that reported "yes" to enrolling in AP Chemistry probably felt that they would need the knowledge for their future university studies. However, the means were lower for students saying yes to AP Chemistry when compared to University Chemistry, leaving me to wonder if the students value the usefulness of an AP Chemistry course or if something discourages them

from taking this course. Perhaps the fact that AP Chemistry is an option in high school but not a requirement also plays a role here.

Students that have a lot of intellectual curiosity (question 1) and are interested in most academic subjects (question 2) are more likely to choose to enroll in AP chemistry and University Chemistry as seen by the means for these questions in Table 3 and Table 4. Since question 2 is reversed worded, the lowest means are the most positive. This pattern exists in both Q1 and Q2, though the difference in mean responses was significantly different for only Q1. Students that reported a general hatred for studying many academic subjects (Table 4, question 5) said they were less likely to consider enrolling in a University Chemistry course. Generally speaking, students with more positive attitudes about academic subjects are more likely to express interest in taking further chemistry courses.

Table 5, below, shows the factor analysis of student academic attitude by the four schools that completed both Q1 and Q2. Only questions with a statistically significant difference between at least two schools were included here. The complete data set is available in Appendix B

Table 5: Factor Analysis of Student Academic Attitude by School

	Question	school	Mean Q1	Mean Q2
1	I have a lot of intellectual curiosity.	1	3.73	3.75 [a]
		2	3.65	3.76
		4	4.08	3.84
		5	4.11	4.44 [a]
6	I learn quickly in most academic subjects.	1	3.56[a]	3.75
		2	3.47	3.65
		4	4.04	3.72
		5	4.22 [a]	4.11
7	I get good marks in most academic subjects.	1	4.08	4.10 [a]
		2	3.94	3.44
		4	4.04	3.56
		5	4.33	4.22 [a]
8	I have trouble with most academic subjects.	1	1.81[a]	1.98[a]
		2	2.71[b]	2.76[b]
		4	2.16	2.48
		5	1.50[a,b]	1.72[a,b]
11	I plan to pursue a course of study in college where knowledge of chemistry is beneficial.	1	2.79 [a]	2.77 [a]
		2	3.00	3.00
		4	3.48	3.60
		5	3.83 [a]	4.17 [a]
	Overall mean academic attitudes by school (reversing questions 2, 5 and 8)	1	3.17	3.22
		2	2.99	2.87
		4	3.40	3.29
		5	3.61	3.60

[a] The mean difference between school 1 and 5 is significant at the p = 0.05 level.
[b] The mean difference between school 2 and 5 is significant at the p = 0.05 level.

When considering the schools that these students attend, Table 5 shows that those students attending school 5 have an overall higher academic attitude than those students in the other schools. This especially true when comparing school 5 to school 1 where the data shows a significant difference between the means for several questions regarding academic attitude in both Q1 and Q2. Schools 4 and 5 were the magnet schools that offered electives in the area of medicine and science, while schools 1 and 2 were the more traditional high schools.

In Table 6, below, the factor analysis results of academic attitude and gender are provided. Again, only questions with statistically significant differences are included here and the complete data set is available in Appendix B

Table 6: Factor Analysis of Student Academic Attitude by gender

	Question	Gender	Mean Q1	Mean Q2
6	I learn quickly in most academic subjects.	M	3.95	4.05*
		F	3.67	3.64*
8	I have trouble with most academic subjects.	M	1.66*	2.00
		F	2.16*	2.28
9	I can often see better ways of doing routine tasks.	M	3.64*	3.68*
		F	3.18*	3.28*
	Overall mean academic attitudes by gender (reversing questions 2, 5 and 8)	M	3.42	3.36
		F	3.19	3.18

* The mean difference between male and female students is significantly different at the p=0.05 level.

When considering student academic attitude by gender (Table 6), it is interesting to note that though the sample size of male students is smaller than the sample size of female students, male students enrolled in Pre-AP chemistry generally had a higher academic attitude than female students. In general, students of both genders had a slight decrease in academic attitude after taking Pre-AP chemistry.

Overall, students with positive academic attitudes are more likely to plan to enroll in further chemistry studies especially if they already know that their career interest will require chemistry. A student's intellectual curiosity can also play a role. It seems that students that attend magnet high schools have more favorable academic attitudes when compared to those high school students that attended regular high schools. Male students seem to have a decrease in academic attitudes, but still have higher academic attitudes than their female peers.

Perceptions

Student perceptions about Chemistry and Chemists can also affect how the student sees themselves in a similar role. There were 22 questions in this section with a seven point Likert scale. The questions were divided into three main sections regarding perceptions of chemists, chemistry research, and chemistry jobs. Table 7 and 8 below include perceptions that had statistically significant differences when compared to their enrollment choice. Table 7 compares the student's perceptions and plans to enroll in AP Chemistry. Table 8 compares the student's perceptions and plans to enroll in University chemistry. The complete data tables can be found in Appendix B.

Table 7: Factor Analysis of Student Perceptions and Plans to Enroll in AP Chemistry

	Question	Enroll in AP Chemistry	Mean Q1	Mean Q2
7	Chemists Inquisitive…….Indifferent	Yes	5.12	5.43[b]
		No	4.45	5.40[c]
		Undecided	5.35	4.49[b,c]
9	Chemists Athletic……..Unfit	Yes	3.72	4.21[b]
		No	2.73	3.90
		Undecided	3.88	3.42[b]
11	Chemistry Research Increases quality of life…….Decreases quality of life	Yes	5.89	6.05[b]
		No	5.73	5.85
		Undecided	5.72	5.22[b]
13	Chemistry Research Advances society……. Causes society to decline	Yes	5.96	6.23[b]
		No	6.09	5.90
		Undecided	5.67	5.57[b]
16	Chemistry Jobs Challenging…….Easy	Yes	5.70[a]	5.67
		No	6.55[a]	6.30
		Undecided	5.84	5.91
18	Chemistry Jobs Interesting…….Boring	Yes	5.38	5.58[b]
		No	4.18	4.55
		Undecided	5.12	4.61[b]
19	Chemistry Jobs Satisfying…….Unsatisfying	Yes	5.15	5.21[a,b]
		No	4.45	4.05[a]
		Undecided	4.63	4.20[b]
20	Chemistry Jobs Exciting…….Tedious	Yes	4.85	5.09[a,b]
		No	4.27	4.05[a]
		Undecided	4.74	4.18[b]
	Overall means	Yes	5.04	5.26
		No	4.64	4.91
		Undecided	5.06	4.82

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.
[c] The mean difference between no and undecided is significant at the p= 0.05 level

Table 8: Factor Analysis of Student Perceptions and Plans to Enroll in University Chemistry

	Question	Enroll in University Chemistry	Mean Q1	Mean Q2
4	Chemists	Yes	5.86[a]	5.86
	Care about the effects of their	No	4.14[a,c]	5.69
	results…….only care about their results	Undecided	6.05[c]	5.70
6	Chemists	Yes	5.07[a]	4.72
	Friendly……Unfriendly	No	3.93[a,c]	4.93
		Undecided	5.13[c]	4.85
9	Chemists	Yes	3.68	3.74
	Athletic…….unfit	No	2.57[c]	3.56
		Undecided	3.95[c]	3.98
12	Chemistry research	Yes	5.96[a]	5.71
	Solves problems…….creates problems	No	5.00[a]	5.25
		Undecided	5.75	5.69
14	Science documentaries	Yes	4.96[a]	5.42
	Enjoyable……Boring	No	2.86[a,c]	2.94
		Undecided	4.48[c]	4.26
15	Chemistry Web Sites	Yes	4.89[a]	4.40[a]
	Interesting…….Boring	No	2.86[a,c]	2.63[a]
		Undecided	4.02[c]	3.79
18	Chemistry Jobs	Yes	5.93[a]	5.67[a,b]
	Interesting…….Boring	No	3.29[a,c]	3.81[a]
		Undecided	5.21[c]	4.83[b]
19	Chemistry Jobs	Yes	5.64[a,b]	5.05[a]
	Satisfying……unsatisfying	No	4.00[a]	3.75[a]
		Undecided	4.75[b]	4.48
20	Chemistry Jobs	Yes	5.32[a]	4.95[a]
	Exciting…….Tedious	No	3.07[a,c]	3.50[a]
		Undecided	4.84[c]	4.50
21	Talking to My Friends about Chemistry	Yes	4.32[a]	4.05[a]
	Interesting……..Boring	No	1.57[a,c]	2.19[a]
		Undecided	3.43[c]	3.25
22	Science Fiction Movies	Yes	5.54	5.67[a]
	Interesting……..Boring	No	4.50	4.31[a]
		Undecided	5.37	5.13
	Overall means	Yes	5.35	5.24
		No	4.32	4.47
		Undecided	5.16	5.00

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.
[c] The mean difference between no and undecided is significant at the p= 0.05 level

For student perceptions, the few questions that related to chemistry jobs (Table 7 and 8; numbers 18, 19, and 20) seemed to have some impact on the decision to take more chemistry courses. Students that expressed interest in enrolling in a second year of chemistry were more likely to have positive perceptions of chemistry jobs when compared to those that were undecided or said no to enrolling in further chemistry courses. There was an overall more positive perception of chemistry and chemists for those students that wished to enroll in AP Chemistry. The means for Q2 in Table 7 showed an increase in perception of chemistry and chemists for those students that wanted to enroll in more chemistry courses, but a decrease in mean for those students that were undecided. Although students that were interested in enrolling in University Chemistry typically had higher perceptions of chemistry and chemists, many of these perceptions seem to decrease after taking Pre-AP Chemistry (Table 8). There is a small decrease in the overall perception means for those students that said they were interested in enrolling in University Chemistry when compared to the overall means of those students that were undecided or said no.

The student's perceptions correlated by school are listed in Table 9. Only those questions that showed a statistically significant difference are shown below. The complete data set can be found in Appendix B.

Table 9: Factor Analysis of Student Perceptions by School

	Question	School	Mean Q1	Mean Q2
1	Chemists	1	5.88	4.52 [a]
	Socially aware…….socially unaware	2	5.53	4.63
		4	6.04	5.48 [a]
		5	5.76	5.17
3	Chemists	1	4.48[a]	4.58
	Flexible in their ideas…….Fixed in their ideas	2	4.24	4.35
		4	5.52[a]	5.17
		5	5.00	4.83
13	Chemistry research	1	5.63	5.83
	Advances society……. Causes society to decline	2	5.47[d]	5.47
		4	6.20	6.20
		5	6.41[d]	6.06
15	Chemistry websites	1	3.67 [a]	3.65
	Interesting…….boring	2	3.47[c]	3.35
		4	4.92[a,c]	4.36
		5	4.59	4.22
16	Chemistry Jobs	1	5.75	5.94
	Challenging…….Easy	2	6.00	6.18[c,d]
		4	5.88	5.36[c]
		5	5.88	6.22[d]
18	Chemistry Jobs	1	5.13	4.55[b]
	Interesting…….Boring	2	4.59	4.53
		4	5.52	5.52
		5	5.24	5.83[b]
19	Chemistry Jobs	1	4.54	4.15[a]
	Satisfying…….Unsatisfying	2	4.76	4.29
		4	5.32	5.36[a]
		5	5.24	4.89
20	Chemistry Jobs	1	4.63	4.25[a]
	Exciting…….tedious	2	4.53	4.06
		4	5.20	5.32[a]
		5	4.65	4.56
	Overall means	1	4.96	4.83
		2	4.81	4.85
		4	5.45	5.34
		5	5.21	5.17

[a] The mean difference between school 1 and 4 is significantly different at the p= 0.05 level.
[b] The mean difference between school 1 and 5 is significantly different at the p= 0.05 level.
[c] The mean difference between school 2 and 4 is significantly different at the p= 0.05 level.
[d] The mean difference between school 2 and 5 is significantly different at the p= 0.05 level.

When considering the student's perceptions by school (Table 9), it is interesting to note that schools 4 and 5 often showed higher means than schools 1 and 2. Again, the nature and focus of these magnet high schools can be considered as a reason for the higher perceptions. However, it is also notable that the means for Q2 compared to Q1 were also often lower for all of the schools. This decline of chemistry perceptions can also be seen in the overall means of the schools with the exception of school 2, which had a small increase in overall perception. One other positive observation is that most of the means are fairly high, with most of the means above 4.00, which shows that many of these high school students have positive perceptions of chemistry and chemists.

Table 10, below, shows the student's perceptions correlated to their gender. Only the questions that showed a statistically significant difference are referenced in this table. The complete data set is in Appendix B.

Table 10: Factor Analysis of Student Perceptions by Gender

	Question	gender	Mean Q1	Mean Q2
4	Chemists	M	5.74	5.41*
	Care about effects of their results…….Only care about their results	F	5.74	5.97*
8	Chemists	M	5.05*	5.08
	Patience…….Impatient	F	5.75*	5.46
10	Chemistry research	M	6.13	5.41
	Helps people…….Harms people	F	5.99	5.87
13	Chemistry research	M	6.23*	6.00
	Advances society…….Causes society to decline	F	5.65*	5.84
17	Chemistry jobs	M	4.87	4.77*
	Varied …….Repetitive	F	5.01	5.36*
	Overall Means	M	5.08	4.96
		F	5.10	5.04

* The mean difference between male and female students is significantly different at the p=0.05 level.

According to the data in Table 10, female students often experienced an increase in their perceptions of chemistry and chemists throughout the Pre-AP Chemistry course, while male

students often experienced a decrease. However, overall both genders seemed to experience a small overall drop in perceptions about chemistry.

In summary, students that had higher perceptions of chemistry and chemists were more motivated to enroll in further chemistry courses. Also, students that attended a magnet high school had more positive perceptions of chemistry compared to students that attended regular high schools, although most schools showed an overall decline in perceptions of chemistry over the course of the school year. This decline in perceptions of chemistry was not reserved to the schools, students of both genders experienced a decrease in their perceptions of chemistry, although female students showed some increases in perceptions of chemists and chemistry jobs for some of the questions asked.

Confidence

To measure the high school students' self-efficacy, or confidence level in chemistry, a 19 question survey was administered. The survey used a five point Likert scale, with a 5 being very confident and a 1 being not confident. Measuring the students' confidence level produced interesting results. In Table 11 and Table 12, the student's confidence levels were compared to their choice to enroll in AP chemistry (Table 11) and University chemistry (Table 12). The data included in these tables is only for questions that showed a statistically significant difference between the student's choices to enroll in further chemistry courses. The complete data tables can be found in Appendix B.

Table 11: Factor Analysis of Student Confidence and Plans to Enroll in AP Chemistry

	Question	Enroll in AP Chemistry	Mean Q1	Mean Q2
2	Reading the procedures for an experiment and conducting the experiment without guidance.	Yes	4.06[a,b]	4.09 [b]
		No	2.64[a]	3.55
		Undecided	3.42[b]	3.62 [b]
3	Designing and conducting a chemistry experiment.	Yes	3.55[b]	3.26
		No	3.09	3.05
		Undecided	2.93[b]	2.91
4	Tutoring another student in a first year chemistry course.	Yes	3.02[b]	3.33 [b]
		No	2.73	2.60
		Undecided	2.35[b]	2.67 [b]
5	Determining what answer is required from a written description of a chemistry problem.	Yes	3.30	3.63 [b]
		No	3.00	3.15
		Undecided	3.09	3.07 [b]
6	Ensuring the data obtained from an experiment is accurate.	Yes	3.96[b]	4.00 [a,b]
		No	3.73	3.25[a]
		Undecided	3.44[b]	3.36[b]
8	Explaining something that you learned in this chemistry course to another person.	Yes	4.07	4.14[b]
		No	3.64	3.60
		Undecided	3.58	3.51[b]
9	Choosing an appropriate formula to solve a chemistry problem.	Yes	3.80	3.88[b]
		No	3.18	3.55
		Undecided	3.56	3.22[b]
10	Knowing how to convert the data obtained in a chemistry experiment into a result.	Yes	3.78[a,b]	3.91[b]
		No	2.91[a]	3.55
		Undecided	3.26[b]	3.31[b]
13	Determining the appropriate units for a result determined using a formula.	Yes	3.68	4.10[b]
		No	3.45	3.58
		Undecided	3.37	3.40[b]
16	Achieving a passing grade in an AP Chemistry course.	Yes	4.24	4.00[a]
		No	3.55	3.15[a]
		Undecided	3.88	3.51
17	Applying theory learned in a lecture for a laboratory experiment.	Yes	3.78	3.72[b]
		No	3.18	3.53
		Undecided	3.35	3.18[b]
18	Writing up the results section in a laboratory report.	Yes	3.80	3.81[b]
		No	3.45	3.39
		Undecided	3.63	3.20[b]
	Overall means	Yes	3.77	3.81
		No	3.32	3.42
		Undecided	3.36	3.34

[a] The mean difference between yes and no is significant at the $p < 0.05$ level.
[b] The mean difference between yes and undecided is significant at the $p < 0.05$ level.
[c] The mean difference between no and undecided is significant at the $p < 0.05$ level

Table 12: Factor Analysis of Student Confidence and Plans to Enroll in University Chemistry

	Question	Enroll in University Chemistry	Mean Q1	Mean Q2
2	Reading the procedures for an experiment and conducting the experiment without guidance.	Yes	4.00[a]	4.00
		No	2.93 [a]	3.44
		Undecided	3.67	3.73
4	Tutoring another student in a first year chemistry course.	Yes	3.14 [a]	3.24
		No	1.79 [a,c]	2.44
		Undecided	2.78 [c]	2.79
5	Determining what answer is required from a written description of a chemistry problem.	Yes	3.39 [a]	3.58[a]
		No	2.43 [a,c]	2.63[a]
		Undecided	3.27 [c]	3.29
6	Ensuring the data obtained from an experiment is accurate.	Yes	3.93	3.93[b]
		No	3.36	3.25
		Undecided	3.72	3.40[b]
10	Knowing how to convert the data obtained in a chemistry experiment into a result.	Yes	3.86	3.98[a,b]
		No	3.07	3.19[a]
		Undecided	3.41	3.38[b]
11	After reading an article about a chemistry experiment, writing a summary of the main points.	Yes	3.89[a]	3.70[a]
		No	2.71[a]	2.69[a]
		Undecided	3.47	3.25
12	Learning chemistry concepts.	Yes	4.04[a]	3.84
		No	3.36[a]	3.38
		Undecided	3.64	3.54
16	Achieving a passing grade in an AP Chemistry course.	Yes	4.14	3.91[a]
		No	3.57	2.88[a,c]
		Undecided	4.05	3.65[c]
17	Applying theory learned in a lecture for a laboratory experiment.	Yes	3.68	3.79[b]
		No	3.07	3.20
		Undecided	3.61	3.25[b]
18	Writing up the results section in a laboratory report.	Yes	3.86	3.70[a]
		No	3.71	2.73[a,c]
		Undecided	3.63	3.50[c]
19	After listening to a public lecture regarding some chemistry topic, explaining its main ideas to another person.	Yes	2.50[a,b]	3.58
		No	3.61[a]	3.31
		Undecided	3.33[b]	3.15
	Overall means	Yes	3.74	3.77
		No	3.15	3.15
		Undecided	3.57	3.47

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.
[c] The mean difference between no and undecided is significant at the p= 0.05 level

Confidence level seems to have a large influence in a student's decision to enroll in further chemistry courses. For a majority of the questions in this section, there were significant differences in the mean responses of those students that decided to enroll in AP chemistry (Table 11) and University Chemistry (Table 12) when compared to those students that were undecided or said no to enrolling in further chemistry courses. When students were asked to rank their confidence level in achieving a passing score in an AP Chemistry course (question 16), the mean responses decreased regardless of their plans to enroll in a second year of chemistry. Those that said yes to enroll in further chemistry courses, however, had significantly higher means in their confidence of passing an AP Chemistry course. Curiously, however, those that said yes to enroll in an AP Chemistry course (Table 11) had a slightly higher mean confidence level on question 16 than those that said yes to enroll in University Chemistry (Table 12). Overall means show that students that were undecided about enrolling in AP or University chemistry had a drop in confidence over the span of the school year, although, students that said no they did not plan to enroll in University chemistry had the lowest overall mean confidence level.

The results of comparing the student's confidence level to their school are found in Table 13. Only questions that showed a statistically significant difference are shown in Table 13. The complete data set can be found in Appendix B.

Table 13: Factor Analysis of Student Confidence by School

	Question	school	Mean Q1	Mean Q2
2	Reading the procedures for an experiment and conducting the experiment without guidance.	1	3.42	3.56 [c]
		2	3.59	3.47 [e]
		4	3.88	4.04
		5	4.06	4.39 [c, e]
4	Tutoring another student in a first year chemistry course.	1	2.54	2.63 [b]
		2	2.12 [d]	2.35 [e]
		4	3.16 [d]	3.46 [b]
		5	3.17	3.50 [e]
6	Ensuring the data obtained from an experiment is accurate.	1	3.71	3.50
		2	3.35	2.88 [d,e]
		4	3.96	4.08 [d]
		5	3.83	3.83 [e]
8	Explaining something that you learned in this chemistry course to another person.	1	3.85	3.77
		2	3.53	3.12 [e]
		4	4.00	3.92
		5	3.83	4.22 [e]
9	Choosing an appropriate formula to solve a chemistry problem.	1	3.58 [c]	3.25 [c]
		2	3.18 [d]	3.29 [d]
		4	4.12 [d]	3.88 [d]
		5	3.56 [c]	4.11 [c]
10	Knowing how to convert the data obtained in a chemistry experiment into a result.	1	3.44	3.52
		2	2.88 [d]	3.29
		4	3.88 [d]	3.72
		5	3.61	3.89
11	After reading an article about a chemistry experiment, writing a summary of the main points.	1	3.19 [b]	3.29
		2	3.76	3.24
		4	3.92 [b]	3.40
		5	3.33	3.44
12	Learning chemistry concepts.	1	3.58 [b]	3.65
		2	3.47	3.12 [d]
		4	4.16 [b]	3.96 [d]
		5	3.56	3.61
13	Determining the appropriate units for a result determined using a formula.	1	3.34 [b]	3.81 [a]
		2	3.29	2.71 [a,d,e]
		4	4.00 [b]	4.21 [d]
		5	3.61	3.71 [e]
16	Achieving a passing grade in an AP Chemistry course.	1	4.15	3.69 [a]
		2	3.59	2.76 [a,d,e]
		4	4.04	3.76 [d]
		5	4.11	4.17 [e]
17	Applying theory learned in a lecture for a laboratory experiment.	1	3.60	3.25 [c]
		2	3.29	3.00 [e]
		4	3.64	3.72
		5	3.50	4.06 [c,e]
18	Writing up the results section in a laboratory report.	1	3.63	3.46 [a]
		2	3.35	2.53 [a,d,e]
		4	3.96	4.08 [d]
		5	3.83	3.61 [e]
	Overall means	1	3.47	3.45
		2	3.33	3.08
		4	3.84	3.82
		5	3.62	3.82

[a] The mean difference between school 1 and 2 is significantly different at the p= 0.05 evel.
[b] The mean difference between school 1 and 4 is significantly different at the p= 0.05 level.
[c] The mean difference between school 1 and 5 is significantly different at the p= 0.05 level.
[d] The mean difference between school 2 and 4 is significantly different at the p= 0.05 level.
[e] The mean difference between school 2 and 5 is significantly different at the p= 0.05 level.

When comparing schools (Table 13), school 5 had a higher mean in Q2 for several questions, including question 16 regarding passing an AP Chemistry Course. Schools 4 and 5 are science based magnet schools. Also, School 2, a traditional high school, is significantly different in several questions in Q2 when compared to the other high schools, and significantly different compared to all of the high schools for question 16 regarding passing an AP Chemistry course. The overall mean confidence levels, for School 2 are lower than the overall mean confidence levels for school 1. The final overall mean confidence level for Schools 4 and 5 were equal. Once again, the overall mean confidence level of all the schools decreased by the end of the school year.

In Table 14, questions with statistically significant differences show how confidence in the chemistry course correlates to gender. The complete data set is available in Appendix B.

Table 14: Factor Analysis of Student Confidence by Gender

	Question	gender	Mean Q1	Mean Q2
3	Designing and conducting a chemistry experiment.	M	3.67*	3.44*
		F	3.01*	2.87*
4	Tutoring another student in a first year chemistry course.	M	3.00	3.26*
		F	2.57	2.72*
5	Determining what answer is required from a written description of a chemistry problem.	M	3.46*	3.64*
		F	3.03*	3.12*
7	Proposing a meaningful question that could be answered experimentally.	M	3.79*	3.44
		F	3.39*	3.30
10	Knowing how to convert the data obtained in a chemistry experiment into a result.	M	3.77*	3.74
		F	3.32*	3.51
13	Determining the appropriate units for a result determined using a formula.	M	3.92*	3.66
		F	3.32*	3.74
16	Achieving a passing grade in an AP Chemistry course.	M	4.28*	3.85
		F	3.88*	3.52
17	Applying theory learned in a lecture for a laboratory experiment.	M	3.87*	3.54
		F	3.36*	3.41
	Overall means	M	3.75	3.65
		F	3.45	3.51

* The mean difference between male and female students is significantly different at the p=0.05 level.

Over the course of the year, most students experienced a drop in confidence in many areas related to chemistry, including confidence in achieving a passing grade in an AP chemistry course (Table 14, question 16). Two notable exceptions to this can be seen in question 4 and 5, where, not too surprisingly, students were more confident about tutoring another student and determining answers required from a chemistry problem once they had completed the course. Another interesting observation is that male students taking chemistry often showed a higher confidence level than female students in the same course even though male students were outnumbered in these classes by 28%. The only exception, for this was in Q2 question 13, where the female student's confidence level increased over the course of the year and passed the male student's confidence level.

In summary, the student's confidence levels seem to drop over the course of the school year. However, those students that planned to enroll in further chemistry courses typically had higher means for confidence level than those that planned not to enroll in further chemistry courses or that were undecided. The students that attended the magnet high schools typically had higher confidence levels than those students that attended regular high schools. Also, while confidence levels seem to decrease in so many areas, including overall confidence in male students, it is the female students that show a slight increase in overall confidence level during the course of the school year.

Expectations and Experiences

The last factor that was considered in this study was the student's expectations (Q1) and experiences (Q2). This part of the survey asked 24 questions using a 5 point Likert scale, where 5 was totally agree and 1 was totally disagree. Then question 25 asked what grade they expected to get in the course. The value of 1 was given to a grade range of 100 to 90. A value of 2 was

given for a grade range of 89-80. A value of 3 was given for a grade range of 79-70. Finally a value of 4 was given for a response of lower than 70.

Table 15 presents the survey results related to experiences in the chemistry course and plans to enroll in AP Chemistry. Only the questions that showed a statistically significant difference are shown. The complete data set can be found in Appendix B.

Table 15: Factor Analysis of Student Experiences and Plans to Enroll in AP Chemistry

	Question	Enroll in AP Chemistry	Mean Q1	Mean Q2
1	My teacher will be/was interested in my progress in chemistry.	Yes	4.10[a]	3.90
		No	3.27[a]	3.75
		Undecided	3.88	3.93
3	My teacher will encourage/encouraged me to take further chemistry courses.	Yes	4.12[a]	3.67
		No	2.91[a]	3.00
		Undecided	3.65	3.41
5	My teacher will make/made me feel that I have the ability to continue in science.	Yes	4.02[a]	3.86
		No	3.18[a]	3.20
		Undecided	3.79	3.36
7	It will be/was easy to talk to my teacher during class to discuss a problem.	Yes	3.82[a]	3.86
		No	2.73[a,c]	3.45
		Undecided	3.70[c]	3.74
16	When writing lab reports, the relationship between the data and the results will be/was clear.	Yes	4.00[a]	4.17
		No	3.00[a]	3.80
		Undecided	3.63	3.82
17	What is required in the write up of an experiment will be/was clear.	Yes	3.18	4.25[a,b]
		No	3.82	3.47[a]
		Undecided	3.51	3.68[b]
19	The laboratory experiments will be/were interesting.	Yes	4.36	4.54[a]
		No	4.04	3.50[a,c]
		Undecided	4.35	4.25[c]
25	What grade do you expect to get in this course?	Yes	1.55	2.25[a]
		No	1.31[c]	1.73[a]
		Undecided	1.73[c]	2.00
	Overall Means (reversing the means for questions 21-24)	Yes	3.76	3.76
		No	3.41	3.46
		Undecided	3.65	3.66

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.
[c] The mean difference between no and undecided is significant at the p= 0.05 level

The data from Table 15 showed that students who planned to enroll in AP Chemistry had higher mean expectations and experiences for most questions when compared to students that did not plan to enroll or were undecided about enrolling in AP Chemistry. Sometimes, the mean experiences (Q1) were lower than the mean expectations (Q2), meaning that the students did not get what they expected. This is true for questions 3 and 5. In Q1 for question 3 the students expressed that they expected for their teacher to encourage them to take further chemistry courses, but in Q2 the student's experiences had a lower mean for the same question. This also can be seen in question 5 where students expected that their teacher would make them feel that they had the ability to continue in science, but their experience had a slightly lower mean. Students that did not plan to enroll in AP Chemistry had lower mean expectations and experiences overall.

Table 16 presents the student's experiences in the chemistry course compared to their plans to enroll in University Chemistry. Only the questions that showed a statistically significant difference are shown. The complete data set can be found in Appendix B.

Table 16: Factor Analysis of Student Experiences and Plans to Enroll in University Chemistry

	Question	Enroll in University Chemistry	Mean Q1	Mean Q2
2	The concepts introduced in class lectures were explained clearly.	Yes	4.15	4.09[a]
		No	3.64	3.25[a]
		Undecided	3.68	3.74
4	The lecture notes were interesting.	Yes	3.56	3.72[a]
		No	2.86	2.38[a]
		Undecided	3.16	3.02
5	My teacher made me feel that I have the ability to continue in science.	Yes	4.30[a]	3.91[a,b]
		No	3.08[a,c]	3.06[a]
		Undecided	3.81[c]	3.37[b]
6	The lecture notes were clearly presented.	Yes	3.96	4.16[a]
		No	3.71	3.44[a]
		Undecided	3.83	3.76
7	It was easy to talk to my teacher during class to discuss a problem.	Yes	4.00[a]	4.02
		No	2.57[a,c]	3.19
		Undecided	3.79[c]	3.67
8	The lectures were presented in an interesting manner.	Yes	3.65	3.86[a]
		No	2.93	2.56[a,c]
		Undecided	3.61	3.41[c]
10	The homework helped me understand the lectures.	Yes	4.12	4.26[a]
		No	3.93	3.44[a]
		Undecided	4.02	4.02
11	The material presented during tutorials was useful.	Yes	4.27	4.12[a,b]
		No	3.79	3.25[a]
		Undecided	4.08	3.53[b]
12	The material covered during tutorials was presented in an interesting manner.	Yes	3.81	3.84[a,b]
		No	3.21	2.69[a]
		Undecided	3.41	3.36[b]
13	It was easy to talk to my teacher during tutorial to discuss a problem.	Yes	4.42[a]	4.09
		No	3.36[a]	3.56
		Undecided	3.95	3.72
14	During tutorial, my teacher explained problems clearly to me.	Yes	4.35	4.30[b]
		No	3.71	3.88
		Undecided	4.14	3.76[b]
16	When writing lab reports, the relationship between the data and the results was clear.	Yes	4.15[a]	4.16
		No	3.07[a,c]	3.56
		Undecided	3.73[c]	3.87
17	What is required in the write up of an experiment is clear.	Yes	3.88	4.05[a]
		No	3.14	3.25[a]
		Undecided	3.65	3.91
18	The theory behind the laboratory experiments was clearly presented.	Yes	3.73	4.07[a]
		No	3.50	3.38[a]
		Undecided	3.67	3.84
19	The laboratory experiments were interesting.	Yes	4.19	4.47[a]
		No	4.07	3.31[a,c]
		Undecided	4.22	4.29[c]
24	The laboratory experiments were confusing.	Yes	2.23[a]	2.33
		No	3.21[a,c]	2.94
		Undecided	2.41[c]	2.49
25	What grade do you expect to get in this course?	Yes	1.35[a]	1.86
		No	1.93[a,c]	2.13
		Undecided	1.49[c]	1.96
	Overall Means (reversing means for questions 21-24)	Yes	3.87	3.89
		No	3.31	3.23
		Undecided	3.69	3.61

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.
[c] The mean difference between no and undecided is significant at the p= 0.05 level

This data indicated that students that did not plan on enrolling in University Chemistry had lower mean expectations and experiences overall. Students that had plans to enroll in University Chemistry always had higher mean expectations and experiences when compared to those students with other plans. Sometimes the means experiences were lower than the mean expectations, such as with question 5 regarding how the teacher made the students feel about their ability to continue in science. All students that did not plan to enroll in University Chemistry, however, experienced a decrease in mean experiences when compared to their mean expectations with the only exception to be question 7 regarding talking to the teacher during class to discuss a problem. In both Table 15 and 16, the overall means changed very little from Q1 to Q2, although those that planned to enroll in further chemistry courses had the highest overall means in both cases and those that did not plan to enroll in further chemistry courses had the lowest overall means.

Table 17, presented below, shows the questions comparing the students experiences by school. The data presented only shows questions that had statistically significant differences. Interestingly, only four questions in this data set did not show statistically significant differences between schools. The complete data set is presented in Appendix B.

Table 17: Factor Analysis of Student Experiences by School

	Question	School	Mean Q1	Mean Q2
1	My teacher will be/was interested in my progress in chemistry.	1	3.70[b]	3.53[b]
		2	3.65[d]	3.82[d]
		4	4.58[b,d]	4.71[b,d,e]
		5	3.89	3.78[e]
2	The concepts introduced in class lectures were explained clearly.	1	3.61[b]	3.77
		2	3.29[d]	3.59
		4	4.46[b,d]	4.33
		5	3.83	3.44
3	My teacher will encourage/encouraged me to take further chemistry courses.	1	3.60[b]	2.87[b]
		2	3.47[d]	3.24[d]
		4	4.58[b,d,e]	4.50[b,d]
		5	3.56[e]	3.67
4	The lecture notes were interesting.	1	3.09[b]	2.91[b]
		2	3.00[d]	2.82[d]
		4	3.96[b,d,e]	4.04[b,d,e]
		5	2.83[e]	3.17[e]
5	My teacher will make/made me feel that I have the ability to continue in science.	1	3.52[b]	3.17[b]
		2	3.65[d]	3.59
		4	4.50[b,d]	4.17[b]
		5	3.94	3.56
6	The lecture notes were clearly presented.	1	3.60[b]	3.91
		2	3.76	3.76
		4	4.42[b]	4.29[e]
		5	3.89	3.33[e]
8	The lectures were presented in an interesting manner.	1	3.28	3.17[b]
		2	3.53	3.76
		4	3.96	3.96[b]
		5	3.56	3.28
12	The material covered during tutorials was presented in an interesting manner.	1	3.32	3.04[b,c]
		2	3.35	3.47
		4	3.91	4.04[b]
		5	3.39	3.72[c]
13	It was easy to talk to my teacher during tutorial to discuss a problem.	1	3.74	3.68
		2	4.41	3.94
		4	4.09	4.04
		5	4.00	4.00
14	During tutorial, my teacher explained problems clearly to me.	1	3.89	3.91
		2	4.47	3.94
		4	4.35	4.25
		5	4.11	4.00
15	The laboratory experiments will be related to the lectures.	1	4.30	4.40
		2	4.35	4.41
		4	4.65	4.78[e]
		5	4.22	3.89[e]

16	When writing lab reports, the relationship between the data and the results will be/was clear.	1	3.57[b]	3.83
		2	3.47[d]	3.88
		4	4.43[b,d, e]	4.22
		5	3.56[e]	4.00
17	What is required in the write up of an experiment will be/was clear.	1	3.51[b]	3.78
		2	3.18[d]	3.35[d]
		4	4.26[b,d]	4.30[d]
		5	3.56	4.00
18	The theory behind the laboratory experiments was clearly presented.	1	3.68	3.74[b]
		2	3.29[d]	3.65[d]
		4	4.09[d]	4.48[b,d,e]
		5	3.39	3.61[e]
19	The laboratory experiments will be/were interesting.	1	4.36	4.11
		2	4.06	4.06
		4	4.30	4.65
		5	3.78	4.11
20	My teacher will be available during lab experiments.	1	4.20	4.40
		2	4.29	4.12
		4	4.52	4.74
		5	4.39	4.28
21	Too many laboratory experiments will be conducted.	1	2.40	2.23[c]
		2	2.59	2.35
		4	3.04	2.27
		5	2.83	3.22[c]
22	The homework given will not be helpful.	1	2.13	2.06[c]
		2	2.41	2.24
		4	1.74	1.73[a]
		5	2.11	2.94[c,a]
23	The lecture notes will be boring.	1	3.19	2.93[b]
		2	2.88	1.78[b,d,e]
		4	2.48	3.00[d]
		5	3.17	3.61[e]
24	The laboratory experiments were confusing.	1	2.64	2.60[b]
		2	2.59	2.59[d]
		4	2.09	1.48[b,d]
		5	2.50	3.39[e]
25	What grade do you expect to get in this course?	1	1.57	1.85
		2	1.59	2.29
		4	1.45	2.08
		5	1.33	1.63
	Overall Means (reversing means for questions 21-24)	1	3.70	3.69
		2	3.72	3.74
		4	4.23	4.24
		5	3.77	3.64

[a] The mean difference between school 1 and 2 is significantly different at the p= 0.05 level.
[b] The mean difference between school 1 and 4 is significantly different at the p= 0.05 level.
[c] The mean difference between school 1 and 5 is significantly different at the p= 0.05 level.
[d] The mean difference between school 2 and 4 is significantly different at the p= 0.05 level.
[e] The mean difference between school 4 and 5 is significantly different at the p= 0.05 level.

The student's expectations and experiences analyzed by school produced interesting results. As seen in table 17, School 4 often showed the highest or most positive means regarding their expectations and experiences. Because this is a smaller magnet school with a medical emphasis, it is possible that students know about the teachers and classes they will take and see the relevance of the chemistry that they are learning. Interestingly, the overall means did not change much from Q1 to Q2 for all of the schools; though, School 4 had the highest overall means and therefore the most positive experiences.

Table 18 shows the overall means for student experiences compared by gender. Remarkably, none of the questions in this section showed statistically significant differences between male and female students. The complete data set is presented in Appendix B.

Table 18: Factor Analysis of Student Experiences by Gender

Question	Gender	Mean Q1	Mean Q2
Overall Means (reversing means for questions 21-24)	M	3.57	3.49
	F	3.57	3.61

Looking at the overall means for the experiences of male and female students, there were no major differences between the expectations and experiences of male and female students. Nonetheless, the overall mean experiences did increase slightly for the female students and decrease slightly for the male students.

In summary, expectations and experiences seem to have the greatest differences between the different schools. This makes sense, since each school and teacher would provide unique experiences, though the material covered should be the same. Also, the students that expressed that they had more positive experiences were more likely to plan on enrolling in a second year of chemistry. Gender seemed to play an insignificant role when it came to student's experiences.

Gender Concerns

When considering overall gender concerns and gender equality in the chemistry classroom, it is perhaps helpful to consider the overall means comparing male and female chemistry students on the different parts of the survey. Table 19 shows the overall means by gender.

Table 19: Overall Means of Factors by Gender

Section	Gender	Mean Q1	Mean Q2
Academic Attitude	M	3.70	3.63
	F	3.46	3.45
Perceptions	M	3.70	3.63
	F	3.46	3.45
Confidence	M	3.75	3.65
	F	3.45	3.51
Expectations and Experiences	M	3.57	3.49
	F	3.57	3.61

It is interesting to note that at the beginning of the school year (see Q1 on Table 19) male students taking chemistry had higher mean scores for academic attitudes, perceptions, and confidence, when compared to the female students in the same classes. Male and female students ranked their expectations equally at the beginning of the school year. However, by the end of the school year, male students saw decreases in the overall means in each of the areas, while female students showed increases in means in confidence and experiences and only slight decreases in their academic attitude and perceptions. Generally, female students saw positive improvements, or no change, in all areas over the course of the school year. Nevertheless, male students often had a higher positive mean than the female students even though their means decreased.

Table 20 shows the distribution of male and female students and their enrollment plans. The raw numbers as well as the percent responses for each enrollment question are presented in the table below.

Table 20: Plans to Enroll in Chemistry by Gender

	1. Do you plan to enroll in AP Chemistry?			2. Do you plan to enroll in chemistry at the university level?		
Gender	Yes %Yes	No %No	Undecided %Undecided	Yes %Yes	No %No	Undecided %Undecided
Q1 Male Students n=39*	5 13%	20 51%	14 36%	5 13.5%	7 19%	25 67.5%
Q2 Male Students n=39**	9 23%	18 46%	12 31%	4 11%	15 39%	19 50%
Q1 Female Students n= 69	6 9%	34 49%	29 42%	9 13%	21 30%	39 57%
Q2 Female Students n=69	11 16%	25 36%	33 48%	12 17%	28 41%	29 42%

*Two students did not respond to question 2.
** One student did not respond to question 2.

The number of both male and female students that planned to enroll in AP chemistry increased by the end of the school year. The number of male students planning to enroll in AP Chemistry increased by 10% while female students that made the same plans only increased by7%. Five percent decreases were seen both for male students that did not plan to enroll in AP Chemistry and those that were undecided about enrolling in AP chemistry over the course of the school year. There was a 6% increase in female students that were undecided about enrolling in AP Chemistry; meanwhile, there was a 13% decrease in female students that said they did not plan to enroll in AP Chemistry. Generally, more students were planning on enrolling in AP chemistry at the end of the school year compared to the beginning; however a larger number of students did not plan on enrolling in AP Chemistry.

For student plans to enroll in University Chemistry, Table 20 shows the number of students that were undecided about enrolling in University Chemistry decreased. For female students, 4% more planned to enroll in University Chemistry, while 11% more said they did not plan to enroll in University Chemistry. The number of male students that said they did not plan to enroll in University Chemistry increased by 20%. In general, a large number of students were undecided about enrolling in University Chemistry. Only a small number of students planned to enroll in University Chemistry

Plans to Enroll in a Second Chemistry Course

One of the main aims of this study is to try to understand what factors affect a student's choice to enroll in further chemistry courses beyond the first year of chemistry in high school. Table 21 shows the survey results for the overall student's plan to enroll in AP Chemistry and University Chemistry. The raw numbers as well as the percent responses for each choice are presented below.

Table 21: Plans to Enroll in Chemistry

Question	1. Do you plan to enroll in AP Chemistry?			2. Do you plan to enroll in chemistry at the university level?		
	Yes %Yes	No %No	Undecided %Undecided	Yes %Yes	No %No	Undecided %Undecided
Q1 (n=108*) *Two students did not respond to question 2,	11 10%	54 50%	43 40%	20 19%	43 40%	45 41%
Q2 (n=108**) ** One student did not respond to question 2.	14 13%	28 26%	64 61%	16 15%	43 40%	48 45%

At the beginning of the school year, only 10% of the PreAP Chemistry students responded that they planned to enroll in AP chemistry. Some reasons students gave for planning

to enroll in AP chemistry were that they enjoyed a challenge, it seemed interesting or fun, and they wanted early college credit. More students said they were undecided or did not plan to enroll in AP Chemistry, though the number of students that were undecided increased by 21% after they had completed the first year of chemistry.

Those students that said that they planned to enroll in University Chemistry seemed to already have a good idea of what career they wanted and that they would need a University Chemistry course. Some career interests for that group included jobs in the health professions, pharmacy, chemical engineering and biochemistry. They also expressed confidence and a general enjoyment of science. At the end of the Pre-AP Chemistry course, students that planned to enroll in AP Chemistry said they would need chemistry for their career and that they were good at chemistry. For University Chemistry, students that felt that this course would be required for their career choice said they did plan on signing up.

Students that did not plan to enroll in AP Chemistry said that they preferred other classes, it was too hard, and that they had no need for that class. After the Pre-AP Chemistry course, these students expressed that they did not like chemistry and that they preferred to choose a different science class. For University Chemistry, students that did not plan to enroll stated that it would be too hard, boring and that chemistry was not required for their career.

Many students were unsure of their plans to enroll in a second year of chemistry. Mostly, it was because of lack of confidence or uncertainty of their future career choice. One student said they needed to see how they did in Pre-AP Chemistry first. Many students that were unsure at the end of Pre-AP Chemistry seemed like they just thought it would be way too much work and they would have too much trouble. Those students that were unsure about University

Chemistry answered in both questionnaires that it depended if the course was required for their career choice. If it was necessary then they would take it, but otherwise, they would not. One student that wanted to be a doctor was not sure if they would need chemistry. This student's statement lead me to wonder how many other students did not realize they would need chemistry in their future.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

Concerns regarding science education worldwide and in the United States have prevailed since the 1980's and many have sought reform in science education. Recent federal programs have brought about research and funding in the area of Science, Technology, Engineering, and Math (STEM) with the purpose of understanding how to increase the number of skilled workers in these areas. In order to increase the workforce in areas of science, it is necessary for science education at all levels to become better at developing able learners and confident thinkers. This study has aimed to understand the motivation of high school students enrolled in a first year of chemistry in South Texas to enroll in a second year of chemistry.

This study proposed that a student's learning experiences coupled with their attitudes, perceptions, and perceived capacity to do chemistry, also known as self-efficacy or confidence level, affect a student's decisions to enroll in a second year of chemistry. The results from this study are able to confirm that there are definite correlations between these factors and a student's plans to enroll in AP and University Chemistry.

Academic attitudes and intellectual curiosity are strong indicators for enrolling in a second year of chemistry. Students that are academically driven and curious to understand the world around them are more inclined to keep studying chemistry. Students that are confident problem solvers seem to be attracted to the challenge of an academically rigorous course like chemistry. Also, the student's perceived need for chemistry in their future studies and career is

paramount. Those students that had already made the connection between chemistry studies and a possible career were more motivated to enroll in a second year of chemistry. The question remains, how those academic attitudes were developed. Before the time they were enrolled in a first year high school chemistry class, many of these students had already decided that they did not want to study more chemistry beyond the high school requirement. Something earlier on in their studies had to have influenced that decision. How did some students become so motivated to study science and others so discouraged by it? When are the critical ages for developing these academic attitudes? What experiences are younger students having, that are shaping these academic attitudes? Answering these questions, could provide further insight as to how to reach more students.

The perceptions of a chemist and chemistry from the perspective of a student show how well that student can relate to the job of a chemist. Those students with higher perceptions showed more interest in pursuing further studies in chemistry. According to this study, these perceptions, coupled with the student's chemistry self-efficacy can influence a student's decision to study chemistry. Those students with positive perceptions and high chemistry self-efficacy were more likely to enroll in further chemistry courses. But, why do the chemistry perceptions typically decrease after the first exposure to a chemistry course? And, can the student's chemistry perceptions be impacted and if so, how? What can be done to increase a student's confidence in their ability to study chemistry? Because so much of a student's self-efficacy will rely on successful experiences in science and math correlations to science, I believe that the answer to these questions lies in positive experiences in science and math early on in education. If science lessons are confusing and not practical, students will not understand how science plays

such an important part of our world. Also, I think emphasis needs to be placed on problem solving and critical thinking skills, which are critical to success in science learning.

It could be argued that a student's lack of participation in further chemistry studies is attributed to the student's lack of science skills. Those skills developed in a first year chemistry course are crucial to the successful continuation in chemistry studies. What factors directly impact these science skills development; teaching methods, learning environment, class size? While this study does show differences in the four teachers that participated, it cannot be certain whether the differences are due specifically to the teacher or rather to the school that this teacher taught at. Students that attended chemistry at the two magnet high school campuses definitely showed more positive patterns towards chemistry all around and towards pursuing further chemistry courses. Perhaps it was the teachers at these schools and the innovative ways they were teaching their course, or perhaps it is the fact that these schools focus on medically related elective courses and therefore draw in a particular type of student. These schools were also smaller and offered less extracurricular programs than the ones offered in the traditional high schools. Could these facts create an environment that is more suitable to learning? To answer this question, we need to consider the way high schools are run today and the impact that magnet high schools have on science education and more specifically chemistry education.

Toward this effort, more schools of this type would have to be studied. Particular attention would have to be drawn to the methods used in teaching chemistry in a magnet school compared to regular high schools. Would any type of magnet high school have the same impact or were these two particularly different due to the nature of their curriculum? Does the size of the campus or extracurricular programs offered matter? Perhaps there is a socioeconomic link that was not considered in the scope of this study. How does the socioeconomic background of

the students attending magnet high schools compare to that of the students attending traditional high schools? Looking into the answers for these questions might provide direction for new high schools that are being developed around the state.

One question yet to be addressed is what is science education like before these students get to high school? Perhaps a look at the teachers and the curriculum provided in the science education of middle school and elementary school students would be insightful. Stronger programs at these levels could provide adequate development of the attitudes and perceived capacity to do chemistry that are desirable. If more students have positive, successful experiences in doing science early on in their academic preparation, then they will be more likely to continue studying science. But are today's elementary teachers themselves adequately prepared to handle this challenge? How can stronger teacher preparation in science be built? Perhaps the STEM programs are already addressing some of these issues. However, more research is needed to find out how confident elementary teacher feel about teaching science.

Lastly, the issue of gender equality was raised in this study. Female students in this study reported lower academic attitudes, chemistry perceptions, and chemistry self-efficacy. Overall, however, female students did have increases in all of these areas while their male peers had decreases. Nevertheless, female students still did not catch up to the male students in any of these areas. They did have positive increases in their experiences compared to the male students who saw small decreases. While the overall differences seem small, more efforts need to be made toward gender equality. One suggestion is to have concerted efforts for current female scientists to mentor female students, providing job shadowing opportunities as well as speaking to groups of female students about their personal experiences in higher level science. Perhaps if

they can meet women who are successfully practicing science, girls can begin to see themselves in the same role.

In conclusion, as the demand for scientists grows in the U.S. and around the world, efforts must be continued to motivate students to study chemistry. Help is needed at all levels of science education to foster good attitudes and perceptions about chemistry and raise chemistry self-efficacy. Providing positive experiences in appropriate learning environments, that meet the expectations of today's young people, can help to create problem solvers and creative thinkers that are driven to continue in this course of study. Questions still remain about how confident elementary educators are with science education, as well as how to develop programs to adequately prepare current and future elementary teachers to teach science and early chemistry concepts. Questions also linger regarding the impact that different learning environments, such as magnet schools and smaller class sizes, might have on motivating students. Answering these types of questions could give us a better understanding of what needs to be done next.

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APPENDIX A

APPENDIX A

QUESTIONNAIRES AND FORMS

Recruitment Email to Chemistry Teachers

Dear Chemistry Teacher,

My name is Nilda Camarena and I am a high school chemistry teacher and a graduate student with the University of Texas Pan American. I am conducting a study regarding the attitudes and experiences of high school Pre AP Chemistry students about chemistry and their intentions of continuing to study chemistry. I am recruiting participants and would like to include input from you and your students. Participation in this study is completely voluntary and confidential. The names of schools and participants will not be disclosed at anytime during the course of this study.

Although you will not have access to the data right away, I will share the aggregate results with you and other chemistry teachers in hopes of gaining insight into how we can better motivate students to continue studying chemistry. Your participation will take minimal time from you and your students; about 1 hour total over a period of time.

Your participation will involve the distribution of consent/assent forms for students to take home to get parent permission to participate as well as the administration of two questionnaires for the students to complete in your class; one at the beginning of the school year and one towards the end of the school year. You will also be required to sign a consent form prior to filling out a teacher questionnaire. The purpose of all of the questionnaires is to gain insight into the attitudes and experiences of these students in your chemistry class.

Again, you are under no obligation to participate in this study and may contact me if you have any questions about the study. I will also need to get permission from your administration to obtain information from your students, so if you will please let me know if I can count on your involvement, I will take care of the rest of the details and contact you with further information.

Thank you for your time and consideration. I look forward to hearing from you soon.

Respectfully yours,

Nilda Camarena

Recruitment Email to Chemistry Administrators

Dear [*administrator name*],

My name is Nilda Camarena and I am a high school chemistry teacher and a graduate student with the University of Texas Pan American. I am conducting a study regarding the attitudes and experiences of high school Pre AP Chemistry students about chemistry and their intentions of continuing to study chemistry. I am recruiting participants and would like to include input from [*chemistry teacher's name*] and [*his/her*] Pre AP Chemistry students. Participation in this study is completely voluntary and confidential. The names of schools and participants will not be disclosed at anytime during the course of this study.

Although you will not have access to the data right away, I will share the aggregate results with [*chemistry teacher name*] and other chemistry teachers in hopes of gaining insight into how we can better motivate students to continue studying chemistry. Your participation will take minimal class time from you and your students; about 1 hour total over a period of time.

The study will include two surveys; one that will be administered at the beginning of the year and one at the end of the year. The questions will be about the student's perceptions, confidence level, and experiences in chemistry as well as their intention to enroll in AP Chemistry.

I have included the parental and student consent forms as well as the survey questions for your review. Should you have any questions about the study, please do not hesitate to contact me. If the procedures involved and have been described to your satisfaction, please let me know if I may include [chemistry teacher's name] students in my study.

Thank you for your time and consideration. I look forward to hearing from you soon.

Respectfully yours,

Nilda Camarena

Teacher Informed Consent Form

The University of Texas - Pan American **Informed Consent Form**

Attitudes and Experiences of High School Chemistry Students

Investigator: Nilda Camarena, BS Chemistry.

Background: I am conducting a research study of the attitudes and experiences of high school Pre-AP Chemistry students in the Rio Grande Valley. I have been a high school chemistry teacher for over ten years and I am currently a chemistry graduate student at UTPA. This study, supervised by Dr. K.C. Smith, will fulfill the research portion of my Master's degree.

Procedure: As a participant in this study you will be completing one survey and administering two surveys to approximately 50 of your students. Very early in the school year, I will ask you to complete a survey about your teaching experience and style. Then you will give your students the assent form and parental consent form to take home and return to you with a few days. At that time you will give those students that have parental consent and have assented to participate, the first of two surveys. It will ask them about their perceptions, confidence, and expectations about this Pre-AP Chemistry course and a few general questions about them. Towards the end of this school year you will administer a similar survey to the students, but this time they will answer questions about their experiences in taking this Pre-AP Chemistry course. The teacher survey should take about 10 minutes to complete. Each student's survey will take approximately 20 minutes to complete during your regular class time. At the end of the course, a list of students indicating if they passed or failed the course would be requested from you. In addition, I might like to interview a few teachers at the end of the study asking for elaboration on their experiences during the course. The interviews will last only 10 to15 minutes and be conducted sometime early summer of 2010.

Risks or Possible Discomforts Associated with the Study: Since students will be asked to be honest and a candid in their response to the questions on the survey, you will be instructed to refrain from seeing any of their responses. Also, the directions for each survey will request that a student be in charge of collecting the surveys, placing them in an envelope provided, and sealing the envelope before handing it to you to return them to me.

Benefits of Participation: My hope is that chemistry teachers throughout the Rio Grande Valley will be able to benefit from this study and make changes that will enhance the class room experiences of all chemistry students. However, no compensation will be given to any participant for participating in this study.

Voluntary Participation: Your participation in this study is completely voluntary; you may discontinue your participation at any time without penalty. You may, at any time, skip over any question you don't want to answer. And, if for any reason you decide that you would like to discontinue your participation, simply return the blank or incomplete surveys to me.

Anonymity and/or Confidentiality: Only I will be allowed to see your responses and when I write my report no student, teacher or school names will be mentioned. Your individual responses will not be released to anyone ever and will be kept securely locked in my office for up to two years after completing the study. Also, any identifying information you should provide will be locked away separately. After two years, all the data will be shredded. Once the final report is completed, you and other chemistry teachers will be allowed to read the final report so we may learn how to improve the Pre-AP chemistry courses we are currently offering to high school students. If a student would like to see all or part of the final report, a copy will be sent to them upon request.

Who to Contact for Research Related Questions: For questions about the research itself, or to report any adverse effects during or following participation, contact Dr. K. C. Smith, at (956) 381-2063.

Who to Contact Regarding Your Rights as a Participant: If you have any questions about your rights as a participant, or if you feel that your rights as a participant were not adequately met by the researcher, contact the Institutional Review Board for Human Subjects Protection at 956-384-5004.

Signatures: Please keep the previous page for your own reference and return the signature page to me along with your student consent forms.

Please indicate your choice below:

☐ Yes, I will participate in this study. ☐ No, I will not participate in this study.

☐ Yes, I am willing to be interviewed. ☐ No, I do not wish to be interviewed.

Email or phone no. for interview:

_____ ____/____/_____

Teacher's Signature Date

Chemistry Teacher Survey

Please bubble in your response.

Part I. Teaching Experience

1. How many years of teaching experience do you have? _____

2. How many years have you taught with this district? _____

3. What courses have you taught?

Chemistry	Biology	Physics	IPC	Other: _____
○ Regular	○ Regular	○ Regular	○ Regular	○ Regular
○ CP	○ CP	○ CP	○ CP	○ CP
○ Pre AP	○ Pre AP	○ Pre AP	○ Pre AP	○ Pre AP
○ AP	○ AP	○ AP	○ AP	○ AP

4. What is your teaching preference?

Chemistry	Biology	Physics	IPC	Other: _____
○ Regular	○ Regular	○ Regular	○ Regular	○ Regular
○ CP	○ CP	○ CP	○ CP	○ CP
○ Pre AP	○ Pre AP	○ Pre AP	○ Pre AP	○ Pre AP
○ AP	○ AP	○ AP	○ AP	○ AP

Part II. Planning for Pre AP Chemistry

5. What primary resource(s) do you use when planning your lessons? (Mark all that apply.)

Text	LTF materials	
○ Holt, *Modern Chemistry*	○ All	○ Internet/ Websites *
○ Glencoe, *Chemistry: Matter and Change*	○ Lessons only	○ District Scope and Sequence
○ Other *	○ Diagnostics only	○ Other resource *

*** Please specify name of resource in the space below**

6. How often do your lessons involve the following teaching strategies? Use the scale below.

1. Never **2**. Seldom **3**. Occasionaly **4**. Often **5**. Always

		1	2	3	4	5
A	Lectures	○	○	○	○	○
B	Discussions	○	○	○	○	○
C	Cooperative learning groups	○	○	○	○	○
D	Mapping (i.e. Concept maps, Thinking maps)	○	○	○	○	○
E	Laboratory experiments	○	○	○	○	○
F	Laboratory demonstrations	○	○	○	○	○
G	Inquiry lessons	○	○	○	○	○
H	Web-based learning (i.e. WebCT)	○	○	○	○	○
J	Other: _____	○	○	○	○	○

Part III. Please answer the questions below. Use the back of this sheet if you need additional space.

7. Describe your teaching style and methods

8. What are your personal teaching goals for this school year?

Student Informed Consent Form

The University of Texas - Pan American **Informed Consent Form**

Attitudes and Experiences of High School Pre AP Chemistry Students

Investigator: Nilda Camarena, BS Chemistry.

Background: I am conducting a research study of the attitudes and experiences of high school Pre-AP Chemistry students in the Rio Grande Valley. I have been a high school chemistry teacher for over ten years and I am currently a chemistry graduate student at UTPA. This study, supervised by Dr. K.C. Smith, will fulfill the research portion of my Master's degree.

Procedure: As a participant in this study you will be completing two surveys. The first survey, to be completed very early in the school year, will ask about your perceptions, confidence, and expectations about this Pre-AP Chemistry course and a few general questions about you. Towards the end of this school year you will complete a similar survey but this time you will answer questions about your experiences in taking this Pre-AP Chemistry course. Each survey will take approximately 20 minutes to complete during your regular class time. In addition, I would like to interview a few students at the end of the study asking for elaboration on their experiences during the course. The interviews will last only 10 to15 minutes and be conducted sometime early summer of 2010. If you agree to be interviewed, I ask that you indicate that at the bottom of this form.

Risks or Possible Discomforts Associated with the Study: Since you will be asked to be honest and a candid in your response to the questions on the survey, your teacher has been instructed to refrain from seeing any of your responses. Also, the directions for each survey will request that a student be in charge of collecting the surveys, placing them in an envelope provided, and sealing the envelope before the teacher returns them to me.

Benefits of Participation: My hope is that chemistry teachers throughout the Rio Grande Valley will be able to benefit from this study and make changes that will enhance the class room experiences of all chemistry students. However, no extra credit or other compensation will be given to any participant for participating in this study.

Voluntary Participation: Your participation in this study is completely voluntary; you may discontinue your participation at any time without penalty. You may, at any time, skip over any question you don't want to answer. And, if for any reason you decide that you would like to discontinue your participation, simply return the blank or incomplete survey to me.

Anonymity and/or Confidentiality: Only I will be allowed to see your responses and when I write my report no student or school names will be mentioned. Your individual responses will not be released to anyone ever and will be kept securely locked in my office for up to two years after completing the study. Also, any identifying information you should provide will be locked away separately. After two years, all the data will be shredded. Once the final report is completed, your teacher and other chemistry teachers will be allowed to read the final report so we may learn how to improve the Pre-AP chemistry courses we are currently offering to high school students. If you would like to see all or part of the final report, a copy will be sent to you upon request.

Who to Contact for Research Related Questions: For questions about the research itself, or to report any adverse effects during or following participation, contact Dr. K. C. Smith, at (956) 381-2063.

Who to Contact Regarding Your Rights as a Participant: If you have any questions about your rights as a participant, or if you feel that your rights as a participant were not adequately met by the researcher, contact the Institutional Review Board for Human Subjects Protection at 956-384-5004.

Signatures: Your parents must consent before you can participate in this study, however, you can refuse to participate even if your parents have agreed to let you participate. Please keep this page for your own reference and return the signature page to your teacher.

The University of Texas - Pan American **Informed Consent Form**

Signature Page

Please indicate your choice below:

☐ Yes, I will participate in this study. ☐ No, I will not participate in this study.

☐ Yes, I am willing to be interviewed. ☐ No, I do not wish to be interviewed.

Email or phone no. for interview:

_____ ____/____/_____

Student's Signature Date

Dear Parent/Guardian,

My name is Nilda Camarena and I am a high school chemistry teacher currently conducting a study as a partial fulfillment of the Master's program in Chemistry from UTPA. I am inviting your child to participate in this study about the attitudes and experiences of high school chemistry students. If your child participates in this study, they will complete two surveys and all of the information they provide will be kept strictly confidential. The information provided by your child will be used to help chemistry teachers make choices that can help improve this course. Details about the study have been provided to your child, however, should you have any questions about the study you may contact my graduate advisor, Dr. K. C. Smith, at (956) 381-2063. If all of the procedures involved have been described to your satisfaction please indicate your consent below.

Estimado Padres/Guardianes,

Me llamo Nilda Camarena, y soy una maestra de química de secundaria actualmente realizando un estudio como el cumplimiento parcial de la Maestría en Química de UTPA. Estoy invitando a su hijo a participar en este estudio sobre las actitudes y experiencias de los estudiantes de escuela secundaria de química. Si su hijo participa en este estudio, que incluirá dos encuestas, toda la información que proporcione será manejada de manera estrictamente confidencial. La información proporcionada por su hijo se utilizará para ayudar a los maestros de química tomar decisiones que pueden ayudar a mejorar este curso. Detalles sobre el estudio se han proporcionado a su hijo, sin embargo, si usted tiene alguna pregunta sobre el estudio puede ponerse en contacto con mi asesor de postgrado, el Dr. Smith KC, al (956) 381-2063. Si todos los procedimientos se han descrito a su satisfacción, por favor, indique su consentimiento a continuación.

Please indicate your choice below:
Por favor, especifique su selección a continuación:

☐ Yes. I allow my child to participate in this study.
Si. Autorizo a mi hijo a participar en este estudio.

☐ No. I will not allow my child to participate in this study.
No. No le permitiré a mi hijo a participar en este estudio.

☐ Yes. I will allow my child to be interviewed.
Si. Yo permito que mi hijo sea entrevistado.

☐ No. I will not allow my child to be interviewed.
No. No le permitiré a mi hijo a ser entrevistados

_____ ____/____/_____

Parent's Signature/ *Firma de Padre* Date/ *Fecha*

Participant Information Sheet

The information you submit in this survey will not be reported on an individual basis. It will be reported on an aggregate level. Please provide your ID number in the boxes. | | | | | | |

Participant Information - Student

Please answer the following questions. This portion of the survey will be separated from the other parts to keep the survey anonymous.

Name (please print) _____

1. Grade level: ○ 9th grade ○ 10th grade ○ 11th grade ○ 12th grade
2. Gender: ○ Male ○ Female
3. Ethnicity: ○ Hispanic ○ White ○ Other_____

Did your parents give you permission to participate in this study? ○ Yes ○ No

If you answered no to the previous question, *please do not continue the survey and let your teacher know*.

If your parents gave you permission and you would like to participate in this study, please continue with the rest of the survey. All of your responses will be kept confidential.

Questionnaire 1

The information you submit in this survey will not be reported on an individual basis. It will be reported on an aggregate level. Please provide your ID number in the boxes. | | | | | | |

Pre-AP Chemistry Questionnaire -1

I. General Information

Please answer the following questions to the best of your ability. Bubble in your answer.

1. Which science courses you have taken?
If you have taken or are taking an AP course write that under other (E-F).

2. How did you do in the science classes you took?
If you did not pass a course the first time but retook it and passed, mark that first level with an ***X***. Then bubble in the level at which you retook it and passed.

	Course	Regular	CP	PreAP	AP	Pass	Did not pass	Never taken	Currently enrolled
A	Biology	○	○	○	○	○	○	○	○
B	IPC	○	○	○	○	○	○	○	○
C	Chemistry	○	○	○	○	○	○	○	○
D	Physics	○	○	○	○	○	○	○	○
E	Other _____	○	○	○	○	○	○	○	○
F	Other _____	○	○	○	○	○	○	○	○

3. Please describe where you attended a majority of middle school and high school. Only fill in information up to your current grade.

	grade	at this school	at another school in this district	at a school in another district in the Rio Grande Valley	at a school outside of the Rio Grande Valley
A	6th	○	○	○	○
B	7th	○	○	○	○
C	8th	○	○	○	○
D	9th	○	○	○	○
E	10th	○	○	○	○
F	11th	○	○	○	○
G	12th	○	○	○	○

4. For this next section, decide how accurately each statement describes you.

1 Not accurate at all **2** Hardly accurate **3** Neutral **4** Somewhat accurate **5** Totally accurate

		1	2	3	4	5
A	I have a lot of intellectual curiosity.	○	○	○	○	○
B	I'm not particularly interested in most academic subjects.	○	○	○	○	○
C	I am good at combining ideas in ways that others have not tried.	○	○	○	○	○
D	I'm good at most academic subjects.	○	○	○	○	○
E	I hate studying many academic subjects.	○	○	○	○	○
F	I learn quickly in most academic subjects.	○	○	○	○	○
G	I get good marks in most academic subjects.	○	○	○	○	○
H	I have trouble with most academic subjects.	○	○	○	○	○
I	I can often see better ways of doing routine tasks.	○	○	○	○	○
J	I enjoy doing work for most academic subjects.	○	○	○	○	○
K	I plan to pursue a course of study in college where knowledge of chemistry is beneficial.	○	○	○	○	○

II. Perceptions

Please rate the perceptions you have about chemistry and related topics. For example, if you feel chemistry is mostly about the study of natural substances and only a little bit about the study of synthetic material then mark your answer like this.

Chemistry: Natural Substances ○ ● ○ ○ ○ ○ ○ Synthetic Material

---

Chemists

Socially aware	○ ○ ○ ○ ○ ○ ○	Socially unaware
Environmentally aware	○ ○ ○ ○ ○ ○ ○	Environmentally unaware
Flexible in their ideas	○ ○ ○ ○ ○ ○ ○	Fixed in their ideas
Care about the effects of their results	○ ○ ○ ○ ○ ○ ○	Only care about their results
Imaginative	○ ○ ○ ○ ○ ○ ○	Unimaginative
Friendly	○ ○ ○ ○ ○ ○ ○	Unfriendly
Inquisitive	○ ○ ○ ○ ○ ○ ○	Indifferent
Patience	○ ○ ○ ○ ○ ○ ○	Impatient
Athletic	○ ○ ○ ○ ○ ○ ○	Unfit

Chemistry Research

Helps people	○ ○ ○ ○ ○ ○ ○	Harms people
Increases quality of life	○ ○ ○ ○ ○ ○ ○	Decreases quality of life
Solves problem	○ ○ ○ ○ ○ ○ ○	Creates problems
Advances society	○ ○ ○ ○ ○ ○ ○	

Science Documentaries

Enjoyable	○ ○ ○ ○ ○ ○ ○	Boring

Chemistry Web Sites

Interesting	○ ○ ○ ○ ○ ○ ○	Boring

Chemistry Jobs

Challenging	○ ○ ○ ○ ○ ○ ○	Easy
Varied	○ ○ ○ ○ ○ ○ ○	Repetitive
Interesting	○ ○ ○ ○ ○ ○ ○	Boring
Satisfying	○ ○ ○ ○ ○ ○ ○	Unsatisfying
Exciting	○ ○ ○ ○ ○ ○ ○	tedious

Talking to My Friends About Chemistry

Interesting	○ ○ ○ ○ ○ ○ ○	Boring

Science Fiction Movies

Interesting	○ ○ ○ ○ ○ ○ ○	Boring

III. Confidence

Please rate the confidence you have in undertaking these different tasks.

	1 Not confident 2 Somewhat unconfident 3 Neutral 4 Somewhat confident 5 Very confident	1	2	3	4	5
1	Achieving a passing grade in a chemical safety quiz.	○	○	○	○	○
2	Reading the procedures for an experiment and conducting the experiment without guidance.	○	○	○	○	○
3	Designing and conducting a chemistry experiment.	○	○	○	○	○
4	Tutoring another student in a first year chemistry course.	○	○	○	○	○
5	Determining what answer is required from a written description of a chemistry problem.	○	○	○	○	○
6	Ensuring the data obtained from an experiment is accurate.	○	○	○	○	○
7	Proposing a meaningful question that could be answered experimentally.	○	○	○	○	○
8	Explaining something that you learned in this chemistry course to another person.	○	○	○	○	○
9	Choosing an appropriate formula to solve a chemistry problem.	○	○	○	○	○
10	Knowing how to convert the data obtained in a chemistry experiment into a result.	○	○	○	○	○
11	After reading an article about a chemistry experiment, writing a summary of the main points.	○	○	○	○	○
12	Learning chemistry concepts.	○	○	○	○	○
13	Determining the appropriate units for a result determined using a formula.	○	○	○	○	○
14	Writing up the experimental procedures in a laboratory report.	○	○	○	○	○
15	After watching a television documentary dealing with some aspect of chemistry, writing a summary of its main points.	○	○	○	○	○
16	Achieving a passing grade in an AP Chemistry course.	○	○	○	○	○
17	Applying theory learned in a lecture for a laboratory experiment.	○	○	○	○	○
18	Writing up the results section in a laboratory report.	○	○	○	○	○
19	After listening to a public lecture regarding some chemistry topic, explaining its main ideas to another person.	○	○	○	○	○

Please add any comments about your confidence level regarding chemistry. You may use an extra page if you need additional space.

20. Do you plan to enroll in AP Chemistry? ○ Yes ○ No ○ Undecided

List at least three reasons for your answer.

21. Do you plan to enroll in chemistry at the university level? ○ Yes ○ No ○ Undecided

List at least three reasons for your answer.

IV. Expectations

Please answer these questions considering all of your experiences in your chemistry class.

	1 Totally disagree **2** Somewhat disagree **3** Neutral **4** Somewhat agree **5** Totally agree	1	2	3	4	5
1	My teacher will be interested in my progress in chemistry.	○	○	○	○	○
2	The concepts introduced in class lectures will be explained clearly.	○	○	○	○	○
3	My teacher will encourage me to take further chemistry courses.	○	○	○	○	○
4	The lecture notes will be interesting.	○	○	○	○	○
5	My teacher will make me feel that I have the ability to continue in science.	○	○	○	○	○
6	The lecture notes will be clearly presented.	○	○	○	○	○
7	It will be easy to talk to my teacher during class to discuss a problem.	○	○	○	○	○
8	The lectures will be presented in an interesting manner.	○	○	○	○	○
9	The homework given will be relevant to the course.	○	○	○	○	○
10	The homework will help me understand the lectures.	○	○	○	○	○
11	The material presented during tutorials will be useful.	○	○	○	○	○
12	The material covered during tutorials will be presented in an interesting manner.	○	○	○	○	○
13	It will be easy to talk to my teacher during tutorial to discuss a problem.	○	○	○	○	○
14	During tutorial, my teacher will explain problems clearly to me.	○	○	○	○	○
15	The laboratory experiments will be related to the lectures.	○	○	○	○	○
16	When writing lab reports, the relationship between the data and the results will be clear.	○	○	○	○	○
17	What is required in the write up of an experiment will be clear.	○	○	○	○	○
18	The theory behind the laboratory experiments will be clearly presented.	○	○	○	○	○
19	The laboratory experiments will b e interesting.	○	○	○	○	○
20	My teacher will be available during lab experiments.	○	○	○	○	○
21	Too many laboratory experiments will be conducted.	○	○	○	○	○
22	The homework given will not be helpful.	○	○	○	○	○
23	The lecture notes will be boring.	○	○	○	○	○
24	The laboratory experiments will be confusing.	○	○	○	○	○

25. What grade do you expect to get in this course? ○ 100-90 ○ 89-80 ○ 79-70 ○ Lower than 70

Please add any comments about your expectations in the chemistry class. Specify if the expectation is for lecture, lab, or tutorial. You may use an extra page if you need additional space.

Questionnaire 2

The information you submit in this survey will not be reported on an individual basis. It will be reported on an aggregate level. Please provide your ID number in the boxes.

Pre-AP Chemistry Questionnaire -2

I. General Information

Please answer the following questions to the best of your ability. Bubble in your answer.

Decide how accurately each statement describes you.

	1 Not accurate at all 2 Hardly accurate 3 Neutral 4 Somewhat accurate 5 Totally accurate	1	2	3	4	5
1	I have a lot of intellectual curiosity.	○	○	○	○	○
2	I'm not particularly interested in most academic subjects.	○	○	○	○	○
3	I am good at combining ideas in ways that others have not tried.	○	○	○	○	○
4	I'm good at most academic subjects.	○	○	○	○	○
5	I hate studying many academic subjects.	○	○	○	○	○
6	I learn quickly in most academic subjects.	○	○	○	○	○
7	I get good marks in most academic subjects.	○	○	○	○	○
8	I have trouble with most academic subjects.	○	○	○	○	○
9	I can often see better ways of doing routine tasks.	○	○	○	○	○
10	I enjoy doing work for most academic subjects.	○	○	○	○	○
11	I plan to pursue a course of study in college where knowledge of chemistry is beneficial.	○	○	○	○	○

1. **Do you plan to enroll in AP Chemistry?** ○ Yes ○ No ○ Undecided

Please list at least three reasons for your answer.

2. **Do you plan to enroll in chemistry at the university level?** ○ Yes ○ No ○ Undecided

Please list at least three reasons for your answer.

II. Perceptions

Please rate the perceptions you have about chemistry and related topics. For example, if you feel chemistry is mostly about the study of natural substances and only a little bit about the study of synthetic material then mark your answer like this.

Chemistry: Natural Substances ○ ● ○ ○ ○ ○ ○ Synthetic Material

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Chemists

Socially aware	○ ○ ○ ○ ○ ○ ○	Socially unaware
Environmentally aware	○ ○ ○ ○ ○ ○ ○	Environmentally unaware
Flexible in their ideas	○ ○ ○ ○ ○ ○ ○	Fixed in their ideas
Care about the effects of their results	○ ○ ○ ○ ○ ○ ○	Only care about their results
Imaginative	○ ○ ○ ○ ○ ○ ○	Unimaginative
Friendly	○ ○ ○ ○ ○ ○ ○	Unfriendly
Inquisitive	○ ○ ○ ○ ○ ○ ○	Indifferent
Patience	○ ○ ○ ○ ○ ○ ○	Impatient
Athletic	○ ○ ○ ○ ○ ○ ○	Unfit

Chemistry Research

Helps people	○ ○ ○ ○ ○ ○ ○	Harms people
Increases quality of life	○ ○ ○ ○ ○ ○ ○	Decreases quality of life
Solves problem	○ ○ ○ ○ ○ ○ ○	Creates problems
Advances society	○ ○ ○ ○ ○ ○ ○	

Science Documentaries

Enjoyable	○ ○ ○ ○ ○ ○ ○	Boring

Chemistry Web Sites

Interesting	○ ○ ○ ○ ○ ○ ○	Boring

Chemistry Jobs

Challenging	○ ○ ○ ○ ○ ○ ○	Easy
Varied	○ ○ ○ ○ ○ ○ ○	Repetitive
Interesting	○ ○ ○ ○ ○ ○ ○	Boring
Satisfying	○ ○ ○ ○ ○ ○ ○	Unsatisfying
Exciting	○ ○ ○ ○ ○ ○ ○	tedious

Talking to My Friends About Chemistry

Interesting	○ ○ ○ ○ ○ ○ ○	Boring

Science Fiction Movies

Interesting	○ ○ ○ ○ ○ ○ ○	Boring

III. Confidence

Please rate the confidence you have in undertaking these different tasks.

	1 Not confident 2 Somewhat unconfident 3 Neutral 4 Somewhat confident 5 Very confident	1	2	3	4	5
1	Achieving a passing grade in a chemical safety quiz.	○	○	○	○	○
2	Reading the procedures for an experiment and conducting the experiment without guidance.	○	○	○	○	○
3	Designing and conducting a chemistry experiment.	○	○	○	○	○
4	Tutoring another student in a first year chemistry course.	○	○	○	○	○
5	Determining what answer is required from a written description of a chemistry problem.	○	○	○	○	○
6	Ensuring the data obtained from an experiment is accurate.	○	○	○	○	○
7	Proposing a meaningful question that could be answered experimentally.	○	○	○	○	○
8	Explaining something that you learned in this chemistry course to another person.	○	○	○	○	○
9	Choosing an appropriate formula to solve a chemistry problem.	○	○	○	○	○
10	Knowing how to convert the data obtained in a chemistry experiment into a result.	○	○	○	○	○
11	After reading an article about a chemistry experiment, writing a summary of the main points.	○	○	○	○	○
12	Learning chemistry concepts.	○	○	○	○	○
13	Determining the appropriate units for a result determined using a formula.	○	○	○	○	○
14	Writing up the experimental procedures in a laboratory report.	○	○	○	○	○
15	After watching a television documentary dealing with some aspect of chemistry, writing a summary of its main points.	○	○	○	○	○
16	Achieving a passing grade in an AP Chemistry course.	○	○	○	○	○
17	Applying theory learned in a lecture for a laboratory experiment.	○	○	○	○	○
18	Writing up the results section in a laboratory report.	○	○	○	○	○
19	After listening to a public lecture regarding some chemistry topic, explaining its main ideas to another person.	○	○	○	○	○

Please add any comments about your confidence level regarding chemistry. You may use an extra page if you need additional space.

IV. Experiences

Please answer these questions considering all of your experiences in your chemistry class.

	1 Totally disagree 2 Somewhat disagree 3 Neutral 4 Somewhat agree 5 Totally agree	1	2	3	4	5
1	My teacher was interested in my progress in chemistry.	○	○	○	○	○
2	The concepts introduced in class lectures were explained clearly.	○	○	○	○	○
3	My teacher encouraged me to take further chemistry courses.	○	○	○	○	○
4	The lecture notes were interesting.	○	○	○	○	○
5	My teacher made me feel that I have the ability to continue in science.	○	○	○	○	○
6	The lecture notes were clearly presented.	○	○	○	○	○
7	It was easy to talk to my teacher during class to discuss a problem.	○	○	○	○	○
8	The lectures were presented in an interesting manner.	○	○	○	○	○
9	The homework given was relevant to the course.	○	○	○	○	○
10	The homework helped me understand the lectures.	○	○	○	○	○
11	The material presented during tutorials was useful.	○	○	○	○	○
12	The material covered during tutorials was presented in an interesting manner.	○	○	○	○	○
13	It was easy to talk to my teacher during tutorial to discuss a problem.	○	○	○	○	○
14	During tutorial, my teacher explained problems clearly to me.	○	○	○	○	○
15	The laboratory experiments were related to the lectures.	○	○	○	○	○
16	When writing lab reports, the relationship between the data and the results was clear.	○	○	○	○	○
17	What is required in the write up of an experiment is clear.	○	○	○	○	○
18	The theory behind the laboratory experiments was clearly presented.	○	○	○	○	○
19	The laboratory experiments were interesting.	○	○	○	○	○
20	My teacher was available during lab experiments.	○	○	○	○	○
21	Too many laboratory experiments were conducted.	○	○	○	○	○
22	The homework given was not helpful.	○	○	○	○	○
23	The lecture notes were boring.	○	○	○	○	○
24	The laboratory experiments were confusing.	○	○	○	○	○

25. What grade do you expect to get in this course? ○ 100-90 ○ 89-80 ○ 79-70 ○ Lower than 70

Please add any comments about your experiences in the chemistry class. Specify if the experience was in lecture, lab, or tutorial. You may use an extra page if you need additional space.

APPENDIX B

APPENDIX B

COMPLETE DATA TABLES

Table 1: Teacher Experience

School	Teaching experience (years)	Years with district	Courses taught	Common practices and strategies
1	4	4	Chemistry Pre-AP Chemistry	Lectures, Discussions, Learning Groups
2	5	5	Chemistry Pre-AP Chemistry AP Chemistry	No response given.
4	20	6	Chemistry Pre-AP Chemistry AP Chemistry Integrated Physics and Chemistry	No response given.
5	4	4	Chemistry Pre-AP Chemistry	No response given.

Table 2: Student Demographics

School	Female	Male	9th grade	10th grade	11th grade	12th grade	totals
1	30	18	0	48	0	0	48
2	11	6	0	17	0	0	17
4	17	8	1	22	2	0	25
5	11	7	1	17	0	0	18
Total sample	69	39	2	104	2	0	n=108

Academic Attitudes

Table 3: Factor Analysis of Academic Attitudes and plans to enroll in AP Chemistry

	Question	Enroll in AP Chemistry	Mean Q1	Mean Q2
1	I have a lot of intellectual curiosity.	Yes	4.13[b]	4.00
		No	3.64	4.10
		Undecided	3.58[b]	3.69
2	I'm not particularly interested in most academic subjects.	Yes	2.11[b]	2.21
		No	2.36	2.60
		Undecided	2.79 [b]	2.73
3	I am good at combining ideas in ways that others have not tried.	Yes	3.35	3.55
		No	3.09	3.30
		Undecided	2.90	3.09
4	I am good at most academic subjects.	Yes	4.15	4.02
		No	4.00	3.60
		Undecided	3.79	3.96
5	I hate studying many academic subjects.	Yes	2.76	2.91
		No	3.09	3.05
		Undecided	3.09	3.02
6	I learn quickly in most academic subjects.	Yes	4.09	3.93
		No	3.27	3.75
		Undecided	3.49	3.67
7	I get good marks in most academic subjects.	Yes	4.20	4.00
		No	3.82	3.68
		Undecided	4.02	3.89
8	I have trouble with most academic subjects.	Yes	1.81	2.19
		No	1.80	2.45
		Undecided	2.23	2.04
9	I can often see better ways of doing routine tasks.	Yes	3.46	3.68[b]
		No	2.82	3.35
		Undecided	3.36	3.22[b]
10	I enjoy doing work for most academic subjects.	Yes	3.02	3.14
		No	2.45	2.55
		Undecided	2.98	2.80
11	I plan to pursue a course of study in college where knowledge of chemistry is beneficial.	Yes	3.48	3.88[a,b]
		No	2.82	2.50[a]
		Undecided	2.84	2.93[b]
	Overall means for academic attitudes (reversing questions 2, 5 and 8)	Yes	3.75	3.72
		No	3.33	3.34
		Undecided	3.35	3.41

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.

Table 4: Factor Analysis of Student Academic Attitudes and plans to enroll in University Chemistry

	Question	Enroll in University Chemistry	Mean Q1	Mean Q2
1	I have a lot of intellectual curiosity.	Yes	4.14[a]	3.98
		No	3.14[a,c]	3.81
		Undecided	3.89[c]	3.83
2	I'm not particularly interested in most academic subjects.	Yes	1.79[a,b]	2.49
		No	3.07[a]	2.38
		Undecided	2.55[b]	2.56
3	I am good at combining ideas in ways that others have not tried.	Yes	3.30	3.55[a]
		No	2.93	2.69[a]
		Undecided	3.13	3.31
4	I am good at most academic subjects.	Yes	3.93	4.02
		No	3.71	3.75
		Undecided	4.05	3.88
5	I hate studying many academic subjects.	Yes	2.36[a,b]	2.56[a,b]
		No	3.50[a]	3.44[a]
		Undecided	3.03[b]	3.23[b]
6	I learn quickly in most academic subjects.	Yes	3.86	3.86
		No	3.36	3.69
		Undecided	3.81	3.75
7	I get good marks in most academic subjects.	Yes	4.18	4.05
		No	3.93	3.81
		Undecided	4.06	3.79
8	I have trouble with most academic subjects.	Yes	2.00	2.02
		No	2.14	2.31
		Undecided	1.94	2.27
9	I can often see better ways of doing routine tasks.	Yes	3.44	3.37
		No	2.86	3.06
		Undecided	3.41	3.56
10	I enjoy doing work for most academic subjects.	Yes	3.46[a,b]	3.07
		No	2.43[a]	2.50
		Undecided	2.83[b]	2.83
11	I plan to pursue a course of study in college where knowledge of chemistry is beneficial.	Yes	3.93[a,b]	4.14[a,b]
		No	2.29[a]	1.75[a]
		Undecided	2.97[b]	2.96[b]
	Overall means for academic attitudes (reversing questions 2, 5 and 8)	Yes	3.83	3.72
		No	3.09	3.18
		Undecided	3.51	3.44

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.
[c] The mean difference between no and undecided is significant at the p = 0.05 level

Table 5: Factor Analysis of Student Academic Attitude by School

	Question	school	Mean Q1	Mean Q2
1	I have a lot of intellectual curiosity.	1	3.73	3.75 [a]
		2	3.65	3.76
		4	4.08	3.84
		5	4.11	4.44 [a]
2	I'm not particularly interested in most academic subjects.	1	2.60	2.42
		2	2.59	2.94
		4	2.28	2.60
		5	1.89	2.17
3	I am good at combining ideas in ways that others have not tried.	1	3.06	3.29
		2	2.94	2.82
		4	3.20	3.56
		5	3.50	3.47
4	I am good at most academic subjects.	1	4.04	3.96
		2	3.59	3.53
		4	3.92	3.88
		5	4.35	4.22
5	I hate studying many academic subjects.	1	3.06	2.98
		2	3.12	3.47
		4	2.64	2.92
		5	2.78	2.61
6	I learn quickly in most academic subjects.	1	3.56[a]	3.75
		2	3.47	3.65
		4	4.04	3.72
		5	4.22 [a]	4.11
7	I get good marks in most academic subjects.	1	4.08	4.10 [a]
		2	3.94	3.44
		4	4.04	3.56
		5	4.33	4.22 [a]
8	I have trouble with most academic subjects.	1	1.81[a]	1.98[a]
		2	2.71[b]	2.76[b]
		4	2.16	2.48
		5	1.50[a,b]	1.72[a,b]
9	I can often see better ways of doing routine tasks.	1	3.30	3.35
		2	3.00	3.00
		4	3.60	3.71
		5	3.47	3.61
10	I enjoy doing work for most academic subjects.	1	2.83	2.81
		2	2.76	2.53
		4	3.16	3.32
		5	3.11	2.83
11	I plan to pursue a course of study in college where knowledge of chemistry is beneficial.	1	2.79 [a]	2.77 [a]
		2	3.00	3.00

	4	3.48	3.60
	5	3.83 [a]	4.17 [a]
Overall mean academic attitudes by school (reversing questions 2, 5 and 8)	1	3.45	3.49
	2	3.27	3.14
	4	3.68	3.56
	5	3.89	3.87

[a] The mean difference between school 1 and 5 is significant at the p = 0.05 level.
[b] The mean difference between school 2 and 5 is significant at the p = 0.05 level.

Table 6: Factor Analysis of Student Academic Attitude by gender

	Question	Gender	Mean Q1	Mean Q2
1	I have a lot of intellectual curiosity.	M	4.00	4.00
		F	3.78	3.83
2	I'm not particularly interested in most academic subjects.	M	2.46	2.36
		F	2.38	2.58
3	I am good at combining ideas in ways that others have not tried.	M	3.36	3.29
		F	3.03	3.32
4	I am good at most academic subjects.	M	4.15	4.10
		F	3.90	3.81
5	I hate studying many academic subjects.	M	2.92	3.13
		F	2.93	2.90
6	I learn quickly in most academic subjects.	M	3.95	4.05*
		F	3.67	3.64*
7	I get good marks in most academic subjects.	M	4.23	3.95
		F	4.01	3.87
8	I have trouble with most academic subjects.	M	1.66*	2.00
		F	2.16*	2.28
9	I can often see better ways of doing routine tasks.	M	3.64*	3.68*
		F	3.18*	3.28*
10	I enjoy doing work for most academic subjects.	M	3.05	2.85
		F	2.88	2.91
11	I plan to pursue a course of study in college where knowledge of chemistry is beneficial.	M	3.31	3.51
		F	3.07	3.07
	Overall mean academic attitudes by gender (reversing questions 2, 5 and 8)	M	3.70	3.63
		F	3.46	3.45

* The mean difference between male and female students is significantly different at the p=0.05 level.

Perceptions

Table 7: Factor Analysis of Student Perceptions and Plans to Enroll in AP Chemistry

	Question	Enroll in AP Chemistry	Mean Q1	Mean Q2
1	Chemists	Yes	5.04	5.21
	Socially aware……Unaware	No	4.55	4.70
		Undecided	4.88	4.62
2	Chemists	Yes	5.68	6.02
	Environmentally	No	6.00	5.35
	Aware……Unaware	Undecided	6.00	5.58
3	Chemists	Yes	4.79	4.98
	Flexible ideas……Fixed ideas	No	4.64	4.55
		Undecided	4.77	4.56
4	Chemists	Yes	5.72	5.83
	Care about the effects of their	No	5.36	5.90
	results…….only care about their results	Undecided	5.86	5.64
5	Chemists	Yes	5.13	5.32
	Imaginative……Unimaginative	No	5.55	4.85
		Undecided	5.56	5.11
6	Chemists	Yes	4.96	4.98
	Friendly……Unfriendly	No	4.64	5.05
		Undecided	4.93	4.55
7	Chemists	Yes	5.12	5.43[b]
	Inquisitive…….Indifferent	No	4.45	5.40[c]
		Undecided	5.35	4.49[b,c]
8	Chemists	Yes	3.72	5.31
	Patient…..Impatient	No	2.73	5.35
		Undecided	3.88	5.32
9	Chemists	Yes	3.72	4.21[b]
	Athletic……..Unfit	No	2.73	3.90
		Undecided	3.88	3.42[b]
10	Chemistry research	Yes	5.98	5.76
	Helps people…….Harms people	No	6.18	5.65
		Undecided	6.07	5.67
11	Chemistry Research	Yes	5.89	6.05[b]
	Increases quality of	No	5.73	5.85
	life…….Decreases quality of life	Undecided	5.72	5.22[b]
12	Chemistry Research	Yes	5.70	5.93
	Solves problems……Creates	No	5.55	5.80

	problems	Undecided	5.72	5.27
13	Chemistry Research	Yes	5.96	6.23[b]
	Advances society……. Causes	No	6.09	5.90
	society to decline	Undecided	5.67	5.57[b]
14	Science documentaries	Yes	4.55	4.32
	Enjoyable……Boring	No	3.27	4.10
		Undecided	4.49	4.89
15	Chemistry Web Sites	Yes	4.21	4.05
	Interesting…….Boring	No	3.00	3.20
		Undecided	4.19	3.98
16	Chemistry Jobs	Yes	5.70[a]	5.67
	Challenging…….Easy	No	6.55[a]	6.30
		Undecided	5.84	5.91
17	Chemistry Jobs	Yes	4.89	5.42
	Varied……Repetitive	No	4.82	5.35
		Undecided	5.09	4.80
18	Chemistry Jobs	Yes	5.38	5.58[b]
	Interesting…….Boring	No	4.18	4.55
		Undecided	5.12	4.61[b]
19	Chemistry Jobs	Yes	5.15	5.21[a,b]
	Satisfying…….Unsatisfying	No	4.45	4.05[a]
		Undecided	4.63	4.20[b]
20	Chemistry Jobs	Yes	4.85	5.09[a,b]
	Exciting…….Tedious	No	4.27	4.05[a]
		Undecided	4.74	4.18[b]
21	Talking to My Friends about	Yes	3.55	3.77
	Chemistry	No	2.45	2.90
	Interesting……..Boring	Undecided	3.47	3.24
22	Science Fiction Movies	Yes	5.19	5.26
	Interesting……..Boring	No	4.91	5.20
		Undecided	5.53	5.24
	Overall means	Yes	5.04	5.26
		No	4.64	4.91
		Undecided	5.06	4.82

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.
[c] The mean difference between no and undecided is significant at the p= 0.05 level

Table 8: Factor Analysis of Student Perceptions and Plans to Enroll in University Chemistry

	Question	Enroll in University Chemistry	Mean Q1	Mean Q2
1	Chemists Socially aware……Unaware	Yes No Undecided	4.82 4.57 5.05	5.17 4.44 4.77
2	Chemists Environmentally Aware……Unaware	Yes No Undecided	5.82 5.79 5.86	5.93 5.19 5.71
3	Chemists Flexible ideas……Fixed ideas	Yes No Undecided	5.04 4.14 4.81	4.84 4.13 4.83
4	Chemists Care about the effects of their results…….only care about their results	Yes No Undecided	5.86[a] 4.14[a,c] 6.05[c]	5.86 5.69 5.70
5	Chemists Imaginative……Unimaginative	Yes No Undecided	5.46 5.07 5.37	5.00 4.56 5.45
6	Chemists Friendly……Unfriendly	Yes No Undecided	5.07[a] 3.93[a,c] 5.13[c]	4.72 4.93 4.85
7	Chemists Inquisitive…….Indifferent	Yes No Undecided	5.41 4.43 5.24	5.21 4.94 4.91
8	Chemists Patient…..Impatient	Yes No Undecided	5.93 4.86 5.48	5.62 5.38 5.02
9	Chemists Athletic……..Unfit	Yes No Undecided	3.68 2.57[c] 3.95[c]	3.74 3.56 3.98
10	Chemistry research Helps people…….Harms people	Yes No Undecided	5.82 6.14 6.10	5.72 5.19 5.89
11	Chemistry Research Increases quality of life…….Decreases quality of life	Yes No Undecided	5.79 5.93 5.84	5.53 5.50 5.85
12	Chemistry Research Solves problems……Creates problems	Yes No Undecided	5.96[a] 5.00[a] 5.75	5.71 5.25 5.69
13	Chemistry Research Advances society……. Causes society to decline	Yes No Undecided	5.93 5.71 5.87	5.90 5.50 6.02

14	Science documentaries Enjoyable……Boring	Yes No Undecided	4.96[a] 2.86[a,c] 4.48[c]	5.42 2.94 4.26
15	Chemistry Web Sites Interesting…….Boring	Yes No Undecided	4.89[a] 2.86[a,c] 4.02[c]	4.40[a] 2.63[a] 3.79
16	Chemistry Jobs Challenging…….Easy	Yes No Undecided	5.68 6.14 5.81	5.93 6.00 5.85
17	Chemistry Jobs Varied……Repetitive	Yes No Undecided	4.79 4.57 5.14	5.26 4.94 5.15
18	Chemistry Jobs Interesting…….Boring	Yes No Undecided	5.93[a] 3.29[a,c] 5.21[c]	5.67[a,b] 3.81[a] 4.83[b]
19	Chemistry Jobs Satisfying…….Unsatisfying	Yes No Undecided	5.64[a,b] 4.00[a] 4.75[b]	5.05[a] 3.75[a] 4.48
20	Chemistry Jobs Exciting…….Tedious	Yes No Undecided	5.32[a] 3.07[a,c] 4.84[c]	4.95[a] 3.50[a] 4.50
21	Talking to My Friends about Chemistry Interesting……..Boring	Yes No Undecided	4.32[a] 1.57[a,c] 3.43[c]	4.05[a] 2.19[a] 3.25
22	Science Fiction Movies Interesting……..Boring	Yes No Undecided	5.54 4.50 5.37	5.67[a] 4.31[a] 5.13
	Overall means	Yes No Undecided	5.35 4.32 5.16	5.24 4.47 5.00

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.
[c] The mean difference between no and undecided is significant at the p= 0.05 level

Table 9: Factor Analysis of Student Perceptions by School

	Question	School	Mean Q1	Mean Q2
1	Chemists	1	4.73	4.52 [a]
	Socially aware……Unaware	2	4.82	4.63
		4	5.36	5.48 [a]
		5	4.94	5.17
2	Chemists	1	5.88	5.63
	Environmentally Aware……Unaware	2	5.53	5.41
		4	6.04	5.96
		5	5.76	5.89
3	Chemists	1	4.48[a]	4.58
	Flexible ideas……Fixed ideas	2	4.24	4.35
		4	5.52[a]	5.17
		5	5.00	4.83
4	Chemists	1	5.83	5.83
	Care about the effects of their	2	5.29	5.47
	results…….only care about their results	4	5.96	5.71
		5	5.59	5.94
5	Chemists	1	5.27	4.90
	Imaginative……Unimaginative	2	4.88	4.81
		4	5.76	5.79
		5	5.41	5.22
6	Chemists	1	4.83	4.73
	Friendly……Unfriendly	2	4.76	4.71
		4	5.40	5.09
		5	4.59	4.78
7	Chemists	1	5.19	4.79
	Inquisitive…….Indifferent	2	4.65	4.94
		4	5.29	5.21
		5	5.29	5.50
8	Chemists	1	5.38	5.58
	Patient…..Impatient	2	5.47	5.18
		4	5.67	4.91
		5	5.69	5.28
9	Chemists	1	3.46	3.67
	Athletic……..Unfit	2	4.06	4.00
		4	3.88	4.25
		5	3.65	3.50

10	Chemistry research Helps people…….Harms people	1 2 4 5	5.96 5.76 6.40 6.00	5.79 5.53 5.83 5.44
11	Chemistry Research Increases quality of life…….Decreases quality of life	1 2 4 5	5.63 5.53 5.92 6.41	5.54 5.35 5.96 5.89
12	Chemistry Research Solves problems……Creates problems	1 2 4 5	5.71 5.29 5.92 5.71	5.55 5.00 6.04 5.89
13	Chemistry Research Advances society……. Causes society to decline	1 2 4 5	5.63 5.47[d] 6.20 6.41[d]	5.83 5.47 6.20 6.06
14	Science documentaries Enjoyable……Boring	1 2 4 5	4.08 4.18 5.16 4.35	3.94 6.06 4.71 4.35
15	Chemistry Web Sites Interesting…….Boring	1 2 4 5	3.67[a] 3.47[c] 4.92[a,c] 4.59	3.65 3.35 4.36 4.22
16	Chemistry Jobs Challenging…….Easy	1 2 4 5	5.75 6.00 5.88 5.88	5.94 6.18[c,d] 5.36[c] 6.22[d]
17	Chemistry Jobs Varied……Repetative	1 2 4 5	5.02 4.76 5.08 4.82	4.90 5.47 5.40 5.17
18	Chemistry Jobs Interesting…….Boring	1 2 4 5	5.13 4.59 5.52 5.24	4.55[b] 4.53 5.52 5.83[b]
19	Chemistry Jobs Satisfying…….Unsatisfying	1 2 4 5	4.54 4.76 5.32 5.24	4.15[a] 4.29 5.36[a] 4.89

20	Chemistry Jobs Exciting…….Tedious	1 2 4 5	4.63 4.53 5.20 4.65	4.25[a] 4.06 5.32[a] 4.56
21	Talking to My Friends about Chemistry Interesting……..Boring	1 2 4 5	3.25 3.18 3.84 3.41	3.04 2.88 4.08 3.83
22	Science Fiction Movies Interesting……..Boring	1 2 4 5	5.10 4.59 5.76 5.88	4.88 4.94 5.68 5.89
	Overall means	1 2 4 5	4.96 4.81 5.45 5.21	4.83 4.85 5.34 5.17

[a] The mean difference between school 1 and 4 is significantly different at the p= 0.05 level.
[b] The mean difference between school 1 and 5 is significantly different at the p= 0.05 level.
[c] The mean difference between school 2 and 4 is significantly different at the p= 0.05 level.
[d] The mean difference between school 2 and 5 is significantly different at the p= 0.05 level.

Table 10: Factor Analysis of Student Perceptions by Gender

	Question	gender	Mean Q1	Mean Q2
1	Chemists Socially aware……Unaware	M F	4.90 4.94	4.67 4.99
2	Chemists Environmentally Aware……Unaware	M F	5.69 5.93	5.64 5.75
3	Chemists Flexible ideas……Fixed ideas	M F	4.79 4.75	4.56 4.81
4	Chemists Care about the effects of their results…….only care about their results	M F	5.74 5.74	5.41* 5.97*
5	Chemists Imaginative……Unimaginative	M F	5.21 5.43	4.92 5.27
6	Chemists Friendly……Unfriendly	M F	4.87 4.94	4.87 4.78
7	Chemists Inquisitive…….Indifferent	M F	5.03 5.21	4.90 5.10
8	Chemists Patient…..Impatient	M F	5.05* 5.75*	5.08 5.46

9	Chemists Athletic……..Unfit	M F	3.74 3.65	3.85 3.81
10	Chemistry research Helps people…….Harms people	M F	6.13 5.99	5.41 5.87
11	Chemistry Research Increases quality of life…….Decreases quality of life	M F	5.69 5.87	5.85 5.57
12	Chemistry Research Solves problems……Creates problems	M F	5.62 5.74	5.69 5.60
13	Chemistry Research Advances society……. Causes society to decline	M F	6.23* 5.65*	6.00 5.84
14	Science documentaries Enjoyable……Boring	M F	4.62 4.26	5.33 4.04
15	Chemistry Web Sites Interesting…….Boring	M F	3.85 4.21	3.69 3.96
16	Chemistry Jobs Challenging…….Easy	M F	5.79 5.87	5.82 5.93
17	Chemistry Jobs Varied……Repetitive	M F	4.87 5.01	4.77* 5.36*
18	Chemistry Jobs Interesting…….Boring	M F	5.31 5.06	4.90 5.04
19	Chemistry Jobs Satisfying…….Unsatisfying	M F	4.87 4.87	4.51 4.61
20	Chemistry Jobs Exciting…….Tedious	M F	4.72 4.76	4.28 4.65
21	Talking to My Friends about Chemistry Interesting……..Boring	M F	3.33 3.44	3.31 3.43
22	Science Fiction Movies Interesting……..Boring	M F	5.74 5.04	5.69 4.99
	Overall Means	M F	5.08 5.10	4.96 5.04

* The mean difference between male and female students is significantly different at the p=0.05 level.

Confidence

Table 11: Factor Analysis of Student Confidence and Plans to Enroll in AP Chemistry

	Question	Enroll in AP Chemistry	Mean Q1	Mean Q2
1	Achieving a passing grade on a safety quiz.	Yes	4.67	4.81
		No	4.09	4.65
		Undecided	4.30	4.64
2	Reading the procedures for an experiment and conducting the experiment without guidance.	Yes	4.06[a,b]	4.09 [b]
		No	2.64[a]	3.55
		Undecided	3.42[b]	3.62 [b]
3	Designing and conducting a chemistry experiment.	Yes	3.55[b]	3.26
		No	3.09	3.05
		Undecided	2.93[b]	2.91
4	Tutoring another student in a first year chemistry course.	Yes	3.02[b]	3.33 [b]
		No	2.73	2.60
		Undecided	2.35[b]	2.67 [b]
5	Determining what answer is required from a written description of a chemistry problem.	Yes	3.30	3.63 [b]
		No	3.00	3.15
		Undecided	3.09	3.07 [b]
6	Ensuring the data obtained from an experiment is accurate.	Yes	3.96[b]	4.00 [a,b]
		No	3.73	3.25[a]
		Undecided	3.44[b]	3.36[b]
7	Proposing a meaningful question that could be answered experimentally	Yes	3.65	3.40
		No	3.73	3.65
		Undecided	3.35	3.18
8	Explaining something that you learned in this chemistry course to another person.	Yes	4.07	4.14[b]
		No	3.64	3.60
		Undecided	3.58	3.51[b]
9	Choosing an appropriate formula to solve a chemistry problem.	Yes	3.80	3.88[b]
		No	3.18	3.55
		Undecided	3.56	3.22[b]
10	Knowing how to convert the data obtained in a chemistry experiment into a result.	Yes	3.78[a,b]	3.91[b]
		No	2.91[a]	3.55
		Undecided	3.26[b]	3.31[b]
11	After reading an article about a chemistry experiment, writing a summary of the main points.	Yes	3.69	3.56
		No	3.18	3.15
		Undecided	3.28	3.20
12	Learning chemistry concepts.	Yes	3.76	3.86
		No	3.82	3.55
		Undecided	3.58	3.44
13	Determining the appropriate units for a result determined using a formula.	Yes	3.68	4.10[b]
		No	3.45	3.58
		Undecided	3.37	3.40[b]

14	Writing up the experimental procedures in a lab report.	Yes	3.70	3.84
		No	3.73	3.75
		Undecided	3.47	3.43
15	After watching a television documentary dealing with some aspect of chemistry, writing a summary of its main points	Yes	3.53	3.51
		No	2.91	2.95
		Undecided	2.98	3.29
16	Achieving a passing grade in an AP Chemistry course.	Yes	4.24	4.00[a]
		No	3.55	3.15[a]
		Undecided	3.88	3.51
17	Applying theory learned in a lecture for a laboratory experiment.	Yes	3.78	3.72[b]
		No	3.18	3.53
		Undecided	3.35	3.18[b]
18	Writing up the results section in a laboratory report.	Yes	3.80	3.81[b]
		No	3.45	3.39
		Undecided	3.63	3.20[b]
19	After listening to a public lecture regarding some chemistry topic, explaining its main ideas to another person.	Yes	3.57	3.47
		No	3.09	3.30
		Undecided	3.00	3.27
	Overall means	Yes	3.77	3.81
		No	3.32	3.42
		Undecided	3.36	3.34

[a] The mean difference between yes and no is significant at the $p < 0.05$ level.
[b] The mean difference between yes and undecided is significant at the $p < 0.05$ level.
[c] The mean difference between no and undecided is significant at the $p < 0.05$ level

Table 12: Factor Analysis of Student Confidence and Plans to Enroll in University Chemistry

	Question	Enroll in University Chemistry	Mean Q1	Mean Q2
1	Achieving a passing grade on a safety quiz.	Yes	4.54	4.77
		No	4.29	4.44
		Undecided	4.45	4.77
2	Reading the procedures for an experiment and conducting the experiment without guidance.	Yes	4.00[a]	4.00
		No	2.93 [a]	3.44
		Undecided	3.67	3.73
3	Designing and conducting a chemistry experiment.	Yes	3.36	3.12
		No	2.57	2.94
		Undecided	3.33	3.10
4	Tutoring another student in a first year chemistry course.	Yes	3.14 [a]	3.24
		No	1.79 [a,c]	2.44
		Undecided	2.78 [c]	2.79
5	Determining what answer is required from a written description of a chemistry problem.	Yes	3.39 [a]	3.58[a]
		No	2.43 [a,c]	2.63[a]
		Undecided	3.27 [c]	3.29

6	Ensuring the data obtained from an experiment is accurate.	Yes	3.93	3.93[b]
		No	3.36	3.25
		Undecided	3.72	3.40[b]
7	Proposing a meaningful question that could be answered experimentally	Yes	3.61	3.49
		No	3.07	3.31
		Undecided	3.63	3.25
8	Explaining something that you learned in this chemistry course to another person.	Yes	4.21	4.05
		No	3.64	3.38
		Undecided	3.75	3.67
9	Choosing an appropriate formula to solve a chemistry problem.	Yes	3.93	3.86
		No	3.50	3.19
		Undecided	3.53	3.38
10	Knowing how to convert the data obtained in a chemistry experiment into a result.	Yes	3.86	3.98[a,b]
		No	3.07	3.19[a]
		Undecided	3.41	3.38[b]
11	After reading an article about a chemistry experiment, writing a summary of the main points.	Yes	3.89[a]	3.70[a]
		No	2.71[a]	2.69[a]
		Undecided	3.47	3.25
12	Learning chemistry concepts.	Yes	4.04[a]	3.84
		No	3.36[a]	3.38
		Undecided	3.64	3.54
13	Determining the appropriate units for a result determined using a formula.	Yes	3.89	3.83
		No	3.36	3.31
		Undecided	3.43	3.72
14	Writing up the experimental procedures in a lab report.	Yes	3.57	3.81
		No	3.21	3.27
		Undecided	3.73	3.65
15	After watching a television documentary dealing with some aspect of chemistry, writing a summary of its main points	Yes	3.44	3.42
		No	2.57	2.88
		Undecided	3.33	3.40
16	Achieving a passing grade in an AP Chemistry course.	Yes	4.14	3.91[a]
		No	3.57	2.88[a,c]
		Undecided	4.05	3.65[c]
17	Applying theory learned in a lecture for a laboratory experiment.	Yes	3.68	3.79[b]
		No	3.07	3.20
		Undecided	3.61	3.25[b]
18	Writing up the results section in a laboratory report.	Yes	3.86	3.70[a]
		No	3.71	2.73[a,c]
		Undecided	3.63	3.50[c]
19	After listening to a public lecture regarding some chemistry topic, explaining its main ideas to another person.	Yes	2.50[a,b]	3.58
		No	3.61[a]	3.31
		Undecided	3.33[b]	3.15
	Overall means	Yes	3.74	3.77
		No	3.15	3.15
		Undecided	3.57	3.47

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.
[c] The mean difference between no and undecided is significant at the p= 0.05 level

Table 13: Factor Analysis of Student Confidence by School

	Question	school	Mean Q1	Mean Q2
1	Achieving a passing grade on a safety quiz.	1	4.50	4.79
		2	4.47	4.47
		4	4.24	4.64
		5	4.67	4.83
2	Reading the procedures for an experiment and conducting the experiment without guidance.	1	3.42	3.56 [c]
		2	3.59	3.47 [e]
		4	3.88	4.04
		5	4.06	4.39 [c, e]
3	Designing and conducting a chemistry experiment.	1	3.04	2.96
		2	3.12	2.88
		4	3.56	3.28
		5	3.53	3.28
4	Tutoring another student in a first year chemistry course.	1	2.54	2.63 [b]
		2	2.12 [d]	2.35 [e]
		4	3.16 [d]	3.46 [b]
		5	3.17	3.50 [e]
5	Determining what answer is required from a written description of a chemistry problem.	1	3.02	3.10
		2	3.06	3.06
		4	3.56	3.72
		5	3.22	3.50
6	Ensuring the data obtained from an experiment is accurate.	1	3.71	3.50
		2	3.35	2.88 [d,e]
		4	3.96	4.08 [d]
		5	3.83	3.83 [e]
7	Proposing a meaningful question that could be answered experimentally	1	3.60	3.42
		2	3.24	2.71
		4	3.72	3.52
		5	3.39	3.56
8	Explaining something that you learned in this chemistry course to another person.	1	3.85	3.77
		2	3.53	3.12 [e]
		4	4.00	3.92
		5	3.83	4.22 [e]
9	Choosing an appropriate formula to solve a chemistry problem.	1	3.58 [c]	3.25 [c]
		2	3.18 [d]	3.29 [d]
		4	4.12 [d]	3.88 [d]
		5	3.56 [c]	4.11 [c]
10	Knowing how to convert the data obtained in a chemistry experiment into a result.	1	3.44	3.52
		2	2.88 [d]	3.29

		4	3.88 [d]	3.72
		5	3.61	3.89
11	After reading an article about a chemistry experiment, writing a summary of the main points.	1	3.19 [b]	3.29
		2	3.76	3.24
		4	3.92 [b]	3.40
		5	3.33	3.44
12	Learning chemistry concepts.	1	3.58 [b]	3.65
		2	3.47	3.12 [d]
		4	4.16 [b]	3.96 [d]
		5	3.56	3.61
13	Determining the appropriate units for a result determined using a formula.	1	3.34 [b]	3.81 [a]
		2	3.29	2.71 [a,d,e]
		4	4.00 [b]	4.21 [d]
		5	3.61	3.71 [e]
14	Writing up the experimental procedures in a laboratory report.	1	3.52	3.43
		2	3.71	3.41
		4	3.72	3.96
		5	3.61	4.06
15	After watching a television documentary dealing with some aspect of chemistry, writing a summary of its main points.	1	2.96	3.13
		2	3.29	3.35
		4	3.75	3.64
		5	3.28	3.33
16	Achieving a passing grade in an AP Chemistry course.	1	4.15	3.69 [a]
		2	3.59	2.76 [a,d,e]
		4	4.04	3.76 [d]
		5	4.11	4.17 [e]
17	Applying theory learned in a lecture for a laboratory experiment.	1	3.60	3.25 [c]
		2	3.29	3.00 [e]
		4	3.64	3.72
		5	3.50	4.06 [c,e]
18	Writing up the results section in a laboratory report.	1	3.63	3.46 [a]
		2	3.35	2.53 [a,d,e]
		4	3.96	4.08 [d]
		5	3.83	3.61 [e]
19	After listening to a public lecture regarding some chemistry topic, explaining its main ideas to another person.	1	3.27	3.40
		2	3.00	2.88
		4	3.64	3.52
		5	3.17	3.44
	Overall means	1	3.47	3.45
		2	3.33	3.08
		4	3.84	3.82
		5	3.62	3.82

[a] The mean difference between school 1 and 2 is significantly different at the p= 0.05 evel.
[b] The mean difference between school 1 and 4 is significantly different at the p= 0.05 level.
[c] The mean difference between school 1 and 5 is significantly different at the p= 0.05 level.
[d] The mean difference between school 2 and 4 is significantly different at the p= 0.05 level.
[e] The mean difference between school 2 and 5 is significantly different at the p= 0.05 level.

Table 14: Factor Analysis of Student Confidence by Gender

	Question	gender	Mean Q1	Mean Q2
1	Achieving a passing grade on a safety quiz.	M	4.62	4.67
		F	4.38	4.74
2	Reading the procedures for an experiment and conducting the experiment without guidance.	M	3.90	3.90
		F	3.52	3.74
3	Designing and conducting a chemistry experiment.	M	3.67*	3.44*
		F	3.01*	2.87*
4	Tutoring another student in a first year chemistry course.	M	3.00	3.26*
		F	2.57	2.72*
5	Determining what answer is required from a written description of a chemistry problem.	M	3.46*	3.64*
		F	3.03*	3.12*
6	Ensuring the data obtained from an experiment is accurate.	M	3.87	3.74
		F	3.65	3.51
7	Proposing a meaningful question that could be answered experimentally.	M	3.79*	3.44
		F	3.39*	3.30
8	Explaining something that you learned in this chemistry course to another person.	M	3.97	3.95
		F	3.75	3.68
9	Choosing an appropriate formula to solve a chemistry problem.	M	3.82	3.64
		F	3.54	3.49
10	Knowing how to convert the data obtained in a chemistry experiment into a result.	M	3.77*	3.74
		F	3.32*	3.51
11	After reading an article about a chemistry experiment, writing a summary of the main points.	M	3.44	3.28
		F	3.49	3.36
12	Learning chemistry concepts.	M	3.90	3.74
		F	3.58	3.57
13	Determining the appropriate units for a result determined using a formula.	M	3.92*	3.66
		F	3.32*	3.74
14	Writing up the experimental procedures in a lab report.	M	3.67	3.51
		F	3.58	3.74
15	After watching a television documentary dealing with some aspect of chemistry, writing a summary of its main points.	M	3.26	3.21
		F	3.24	3.38
16	Achieving a passing grade in an AP Chemistry course.	M	4.28*	3.85
		F	3.88*	3.52
17	Applying theory learned in a lecture for a laboratory experiment.	M	3.87*	3.54
		F	3.36*	3.41
18	Writing up the results section in a laboratory report.	M	3.85	3.50
		F	3.61	3.46
19	After listening to a public lecture regarding some chemistry topic, explaining its main ideas to another person.	M	3.28	3.56
		F	3.30	3.23
	Overall means	M	3.75	3.65
		F	3.45	3.51

Expectations/ Experiences

Table 15: Factor Analysis of Student Experiences and Plans to Enroll in AP Chemistry

	Question	Enroll in AP Chemistry	Mean Q1	Mean Q2
1	My teacher will be/was interested in my progress in chemistry.	Yes	4.10[a]	3.90
		No	3.27[a]	3.75
		Undecided	3.88	3.93
2	The concepts introduced in class lectures were explained clearly.	Yes	3.96	3.83
		No	3.36	3.50
		Undecided	3.69	3.93
3	My teacher will encourage/encouraged me to take further chemistry courses.	Yes	4.12[a]	3.67
		No	2.91[a]	3.00
		Undecided	3.65	3.41
4	The lecture notes were interesting.	Yes	3.37	3.43
		No	3.18	2.90
		Undecided	3.07	3.11
5	My teacher will make/made me feel that I have the ability to continue in science.	Yes	4.02[a]	3.86
		No	3.18[a]	3.20
		Undecided	3.79	3.36
6	The lecture notes were clearly presented.	Yes	3.94	3.98
		No	3.73	3.65
		Undecided	3.79	3.89
7	It will be/was easy to talk to my teacher during class to discuss a problem.	Yes	3.82[a]	3.86
		No	2.73[a,c]	3.45
		Undecided	3.70[c]	3.74
8	The lectures were presented in an interesting manner.	Yes	3.71	3.57
		No	3.09	3.00
		Undecided	3.40	3.57
9	The homework given will be relevant to the course.	Yes	4.33	4.33
		No	4.36	4.45
		Undecided	4.33	4.64
10	The homework helped me understand the lectures.	Yes	3.98	4.14
		No	3.73	3.55
		Undecided	4.16	4.16
11	The material presented during tutorials was useful.	Yes	4.10	3.90
		No	4.18	3.65
		Undecided	4.02	3.59
12	The material covered during tutorials was presented in an interesting manner.	Yes	3.65	3.66
		No	3.36	3.20
		Undecided	3.28	3.36
13	It was easy to talk to my teacher during tutorial to discuss a problem.	Yes	4.20	4.05
		No	3.36	3.85
		Undecided	3.86	3.68

14	During tutorial, my teacher explained problems clearly to me.	Yes	4.24	4.10
		No	4.00	4.00
		Undecided	4.02	3.93
15	The laboratory experiments will be related to the lectures.	Yes	4.45	4.43
		No	4.18	4.20
		Undecided	4.33	4.47
16	When writing lab reports, the relationship between the data and the results will be/was clear.	Yes	4.00[a]	4.17
		No	3.00[a]	3.80
		Undecided	3.63	3.82
17	What is required in the write up of an experiment will be/was clear.	Yes	3.18	4.25 [a,b]
		No	3.82	3.47 [a]
		Undecided	3.51	3.68 [b]
18	The theory behind the laboratory experiments was clearly presented.	Yes	3.75	4.07
		No	3.18	3.75
		Undecided	3.67	3.73
19	The laboratory experiments will be/were interesting.	Yes	4.36	4.54 [a]
		No	4.04	3.50 [a,c]
		Undecided	4.35	4.25 [c]
20	My teacher will be available during lab experiments.	Yes	4.49	4.34
		No	4.40	4.30
		Undecided	4.10	4.52
21	Too many laboratory experiments will be conducted.	Yes	2.90	2.60
		No	2.91	2.35
		Undecided	2.28	2.32
22	The homework given will not be helpful.	Yes	2.24	2.30
		No	2.18	2.30
		Undecided	1.88	2.00
23	The lecture notes will be boring.	Yes	3.04	2.73
		No	3.18	3.10
		Undecided	2.86	2.74
24	The laboratory experiments were confusing.	Yes	2.27	2.34
		No	2.73	2.65
		Undecided	2.67	2.55
25	What grade do you expect to get in this course?	Yes	1.55	2.25[a]
		No	1.31[c]	1.73[a]
		Undecided	1.73[c]	2.00
	Overall Means (reversing means for questions 21-24)	Yes	3.53	3.55
		No	3.21	3.24
		Undecided	3.37	3.40

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 level.
[c] The mean difference between no and undecided is significant at the p= 0.05 level

Table 16: Factor Analysis of Student Experiences and Plans to Enroll in University Chemistry

	Question	Enroll in University Chemistry	Mean Q1	Mean Q2
1	My teacher will be/was interested in my progress in chemistry.	Yes	4.11	4.02
		No	3.71	3.63
		Undecided	3.87	3.85
2	The concepts introduced in class lectures were explained clearly.	Yes	4.15	4.09[a]
		No	3.64	3.25[a]
		Undecided	3.68	3.74
3	My teacher will encourage/encouraged me to take further chemistry courses.	Yes	4.04	3.79
		No	3.21	2.94
		Undecided	3.81	3.28
4	The lecture notes were interesting.	Yes	3.56	3.72[a]
		No	2.86	2.38[a]
		Undecided	3.16	3.02
5	My teacher will make/made me feel that I have the ability to continue in science.	Yes	4.30[a]	3.91[a,b]
		No	3.08[a,c]	3.06[a]
		Undecided	3.81[c]	3.37[b]
6	The lecture notes were clearly presented.	Yes	3.96	4.16[a]
		No	3.71	3.44[a]
		Undecided	3.83	3.76
7	It will be/was easy to talk to my teacher during class to discuss a problem.	Yes	4.00[a]	4.02
		No	2.57[a,c]	3.19
		Undecided	3.79[c]	3.67
8	The lectures were presented in an interesting manner.	Yes	3.65	3.86[a]
		No	2.93	2.56[a,c]
		Undecided	3.61	3.41[c]
9	The homework given will be relevant to the course.	Yes	4.42	4.53
		No	4.21	4.44
		Undecided	4.32	4.46
10	The homework helped me understand the lectures.	Yes	4.12	4.26[a]
		No	3.93	3.44[a]
		Undecided	4.02	4.02
11	The material presented during tutorials was useful.	Yes	4.27	4.12[a,b]
		No	3.79	3.25[a]
		Undecided	4.08	3.53[b]
12	The material covered during tutorials was presented in an interesting manner.	Yes	3.81	3.84[a,b]
		No	3.21	2.69[a]
		Undecided	3.41	3.36[b]
13	It was easy to talk to my teacher during tutorial to discuss a problem.	Yes	4.42[a]	4.09
		No	3.36[a]	3.56
		Undecided	3.95	3.72
14	During tutorial, my teacher explained problems clearly to me.	Yes	4.35	4.30[b]
		No	3.71	3.88
		Undecided	4.14	3.76[b]

15	The laboratory experiments will be related to the lectures.	Yes	4.46	4.44
		No	4.14	4.07
		Undecided	4.41	4.48
16	When writing lab reports, the relationship between the data and the results will be/was clear.	Yes	4.15[a]	4.16
		No	3.07[a,c]	3.56
		Undecided	3.73[c]	3.87
17	What is required in the write up of an experiment will be/was clear.	Yes	3.88	4.05[a]
		No	3.14	3.25[a]
		Undecided	3.65	3.91
18	The theory behind the laboratory experiments was clearly presented.	Yes	3.73	4.07[a]
		No	3.50	3.38[a]
		Undecided	3.67	3.84
19	The laboratory experiments will be/were interesting.	Yes	4.19	4.47[a]
		No	4.07	3.31[a,c]
		Undecided	4.22	4.29[c]
20	My teacher will be available during lab experiments.	Yes	4.42	4.56
		No	4.38	4.19
		Undecided	4.27	4.33
21	Too many laboratory experiments will be conducted.	Yes	2.62	2.67
		No	3.00	2.50
		Undecided	2.60	2.22
22	The homework given will not be helpful.	Yes	2.27	2.07
		No	2.50	2.44
		Undecided	1.94	2.20
23	The lecture notes will be boring.	Yes	2.88	2.51
		No	3.43	3.38
		Undecided	2.95	2.87
24	The laboratory experiments were confusing.	Yes	2.23[a]	2.33
		No	3.21[a,c]	2.94
		Undecided	2.41[c]	2.49
25	What grade do you expect to get in this course?	Yes	1.35[a]	1.86
		No	1.93[a,c]	2.13
		Undecided	1.49[c]	1.96
	Overall Means (reversing means for questions 21-24)	Yes	3.59	3.61
		No	3.24	3.11
		Undecided	3.42	3.36

[a] The mean difference between yes and no is significant at the p = 0.05 level.
[b] The mean difference between yes and undecided is significant at the p = 0.05 laevel.
[c] The mean difference between no and undecided is significant at the p= 0.05 level

Table 17: Factor Analysis of Student Experiences by School

	Question	School	Mean Q1	Mean Q2
1	My teacher will be/was interested in my progress in chemistry.	1	3.70[b]	3.53[b]
		2	3.65[d]	3.82[d]
		4	4.58[b,d]	4.71[b,d,e]
		5	3.89	3.78[e]
2	The concepts introduced in class lectures were explained clearly.	1	3.61[b]	3.77
		2	3.29[d]	3.59
		4	4.46[b,d]	4.33
		5	3.83	3.44
3	My teacher will encourage/encouraged me to take further chemistry courses.	1	3.60[b]	2.87[b]
		2	3.47[d]	3.24[d]
		4	4.58[b,d,e]	4.50[b,d]
		5	3.56[e]	3.67
4	The lecture notes were interesting.	1	3.09[b]	2.91[b]
		2	3.00[d]	2.82[d]
		4	3.96[b,d,e]	4.04[b,d,e]
		5	2.83[e]	3.17[e]
5	My teacher will make/made me feel that I have the ability to continue in science.	1	3.52[b]	3.17[b]
		2	3.65[d]	3.59
		4	4.50[b,d]	4.17[b]
		5	3.94	3.56
6	The lecture notes were clearly presented.	1	3.60[b]	3.91
		2	3.76	3.76
		4	4.42[b]	4.29[e]
		5	3.89	3.33[e]
7	It will be/was easy to talk to my teacher during class to discuss a problem.	1	3.38	3.43
		2	3.71	3.88
		4	3.87	3.96
		5	4.06	4.06
8	The lectures were presented in an interesting manner.	1	3.28	3.17[b]
		2	3.53	3.76
		4	3.96	3.96[b]
		5	3.56	3.28
9	The homework given will be relevant to the course.	1	4.17	4.66
		2	4.29	4.35
		4	4.74	4.54
		5	4.28	4.06
10	The homework helped me understand the lectures.	1	3.89	4.04
		2	3.71	3.71
		4	4.65	4.33
		5	3.89	3.94
11	The material presented during tutorials was useful.	1	3.98	3.55
		2	4.24	3.47
		4	4.22	4.13

		5	4.00	3.89
12	The material covered during tutorials was presented in an interesting manner.	1	3.32	3.04[b,c]
		2	3.35	3.47
		4	3.91	4.04[b]
		5	3.39	3.72[c]
13	It was easy to talk to my teacher during tutorial to discuss a problem.	1	3.74	3.68
		2	4.41	3.94
		4	4.09	4.04
		5	4.00	4.00
14	During tutorial, my teacher explained problems clearly to me.	1	3.89	3.91
		2	4.47	3.94
		4	4.35	4.25
		5	4.11	4.00
15	The laboratory experiments will be related to the lectures.	1	4.30	4.40
		2	4.35	4.41
		4	4.65	4.78
		5	4.22	3.89
16	When writing lab reports, the relationship between the data and the results will be/was clear.	1	3.57	3.83
		2	3.47	3.88
		4	4.43	4.22
		5	3.56	4.00
17	What is required in the write up of an experiment will be/was clear.	1	3.51	3.78
		2	3.18	3.35
		4	4.26	4.30
		5	3.56	4.00
18	The theory behind the laboratory experiments was clearly presented.	1	3.68	3.74
		2	3.29	3.65
		4	4.09	4.48
		5	3.39	3.61
19	The laboratory experiments will be/were interesting.	1	4.36	4.11
		2	4.06	4.06
		4	4.30	4.65
		5	3.78	4.11
20	My teacher will be available during lab experiments.	1	4.20	4.40
		2	4.29	4.12
		4	4.52	4.74
		5	4.39	4.28
21	Too many laboratory experiments will be conducted.	1	2.40	2.23
		2	2.59	2.35
		4	3.04	2.27
		5	2.83	3.22
22	The homework given will not be helpful.	1	2.13	2.06[c]
		2	2.41	2.24
		4	1.74	1.73[a]

		5	2.11	2.94[c,a]
23	The lecture notes will be boring.	1	3.19	2.93[b]
		2	2.88	1.78[b,d,e]
		4	2.48	3.00[d]
		5	3.17	3.61[e]
24	The laboratory experiments were confusing.	1	2.64	2.60
		2	2.59	2.59
		4	2.09	1.48
		5	2.50	3.39
25	What grade do you expect to get in this course?	1	1.57	1.85
		2	1.59	2.29
		4	1.45	2.08
		5	1.33	1.63
	Overall Means (reversing means for questions 21-24)	1	3.45	3.42
		2	3.49	3.44
		4	3.89	3.88
		5	3.52	3.62

[a] The mean difference between school 1 and 2 is significantly different at the p= 0.05 level.
[b] The mean difference between school 1 and 4 is significantly different at the p= 0.05 level.
[c] The mean difference between school 1 and 5 is significantly different at the p= 0.05 level.
[d] The mean difference between school 2 and 4 is significantly different at the p= 0.05 level.
[e] The mean difference between school 4 and 5 is significantly different at the p= 0.05 level.

Table 18: Factor Analysis of Student Experiences by Gender

	Question	School	Mean Q1	Mean Q2
1	My teacher will be/was interested in my progress in chemistry.	M	3.95	3.79
		F	3.91	3.94
2	The concepts introduced in class lectures were explained clearly.	M	3.66	3.79
		F	3.87	3.82
3	My teacher will encourage/encouraged me to take further chemistry courses.	M	3.82	3.28
		F	3.79	3.52
4	The lecture notes were interesting.	M	3.18	3.05
		F	3.25	3.28
5	My teacher will make/made me feel that I have the ability to continue in science.	M	3.70	3.36
		F	3.91	3.63
6	The lecture notes were clearly presented.	M	3.76	3.64
		F	3.91	4.01
7	It will be/was easy to talk to my teacher during class to discuss a problem.	M	3.65	3.54
		F	3.66	3.85
8	The lectures were presented in an interesting manner.	M	3.57	3.18
		F	3.49	3.63
9	The homework given will be relevant to the course.	M	4.27	4.41
		F	4.37	4.52

10	The homework helped me understand the lectures.	M F	4.00 4.04	3.90 4.12
11	The material presented during tutorials was useful.	M F	4.05 4.09	3.77 3.70
12	The material covered during tutorials was presented in an interesting manner.	M F	3.27 3.57	3.36 3.50
13	It was easy to talk to my teacher during tutorial to discuss a problem.	M F	3.86 4.03	3.72 3.94
14	During tutorial, my teacher explained problems clearly to me.	M F	4.08 4.15	3.87 4.09
15	The laboratory experiments will be related to the lectures.	M F	4.41 4.35	4.26 4.48
16	When writing lab reports, the relationship between the data and the results will be/was clear.	M F	3.73 3.75	3.90 3.98
17	What is required in the write up of an experiment will be/was clear.	M F	3.81 3.53	3.64 4.00
18	The theory behind the laboratory experiments was clearly presented.	M F	3.78 3.59	3.90 3.85
19	The laboratory experiments will be/were interesting.	M F	4.30 4.15	4.15 4.26
20	My teacher will be available during lab experiments.	M F	4.35 4.30	4.36 4.44
21	Too many laboratory experiments will be conducted.	M F	2.73 2.60	2.49 2.40
22	The homework given will not be helpful.	M F	2.16 2.04	2.26 2.12
23	The lecture notes will be boring.	M F	3.16 2.88	3.13 2.61
24	The laboratory experiments were confusing.	M F	2.51 2.47	2.54 2.45
25	What grade do you expect to get in this course?	M F	1.43 1.55	1.84 2.00
	Overall Means (reversing means for questions 21-24)	M F	3.57 3.57	3.49 3.61

* The mean difference between male and female is significantly different at the p= 0.05 level.

Table 19: Overall Gender Means

Section	Gender	Mean Q1	Mean Q2
Academic Attitude	M	3.70	3.63
	F	3.46	3.45
Perceptions	M	3.70	3.63
	F	3.46	3.45
Confidence	M	3.75	3.65
	F	3.45	3.51
Expectations and Experiences	M	3.57	3.49
	F	3.57	3.61

Table 20: Plans to Enroll in Chemistry by Gender

	1. Do you plan to enroll in AP Chemistry?			2. Do you plan to enroll in chemistry at the university level?		
Gender	Yes %Yes	No %No	Undecided %Undecided	Yes %Yes	No %No	Undecided %Undecided
Q1 Male Students n=39*	5 13%	20 51%	14 36%	5 13.5%	7 19%	25 67.5%
Q2 Male Students n=39**	9 23%	18 46%	12 31%	4 11%	15 39%	19 50%
Q1 Female Students n= 69	6 9%	34 49%	29 42%	9 13%	21 30%	39 57%
Q2 Female Students n=69	11 16%	25 36%	33 48%	12 17%	28 41%	29 42%

*Two students did not respond to question 2,
** One student did not respond to question 2.

Table 21: Plans to Enroll in Chemistry

Question	3. Do you plan to enroll in AP Chemistry?			4. Do you plan to enroll in chemistry at the university level?		
	Yes %Yes	No %No	Undecided %Undecided	Yes %Yes	No %No	Undecided %Undecided
Q1 (n=108*) *Two students did not respond to question 2,	11 10%	54 50%	43 40%	20 19%	43 40%	45 41%
Q2 (n=108**) ** One student did not respond to question 2.	14 13%	28 26%	64 61%	16 15%	43 40%	48 45%

BIOGRAPHICAL SKETCH

Nilda Nydia Camarena graduated from Nikki Rowe High School in McAllen, Texas and completed her Bachelor of Science in Chemistry from the University of Texas Pan American (UTPA) in Edinburg, Texas. While studying at UTPA, she worked as an undergraduate research assistant with Dr. Hassan Ahmad. Upon graduating from UTPA in 1998, Nilda Camarena returned to Nikki Rowe High School to teach Chemistry and Integrated Physics and Chemistry. In 2007, she went to work with South Texas Independent School District at The Business, Education, & Technology Academy (B.E.T.A.) in Edinburg, Texas to teach Chemistry. Nilda Camarena completed a Master of Science in Chemistry from the University of Texas Pan American in December 2014. She currently works and resides in Edinburg, Texas. Correspondence can be sent to 1100 W. Sprague St, Edinburg, TX, 78539.