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FEMALE AND MALE SUCCESS IN A CHEMISTRY CLASSROOM

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FEMALE AND MALE SUCCESS IN A CHEMISTRY CLASSROOM

By

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DEDICATION

In Memory of
Dora Jean Reed Greenwood
Mother and Scientist

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PURPOSE

While I was being interviewed for a position as a high school chemistry teacher the interviewer stated, "You are a minority: You are a woman in science." This statement surprised me, and I began to question if there were less females in science and if so, why.

In 1988, a survey conducted by the National Science Foundation (NSF) showed that only 18% of the employed chemists in the United States were female. This has increased from 11% in 1978.[1] However, in the past three years, an average of 57.5% of the students who have enrolled in chemistry at the high school studied have been females. It seems odd that so few females succeed in pursuing a career of chemistry when, initially, over half of the students are female.

Many factors may cause the "leak in the pipeline." Some may be directly related to the inherent physical differences between men and women, such as, the different ways in which the sexes

process information. Society may also be a factor through discrimination and stereotyping in educational institutions and in the work place. In addition, women have typically migrated from the "pure sciences," such as chemical research, to an "applied science," such as nursing. These applied sciences are not considered to be chemistry careers. Family values involving marriage and children may also play a part. However, each of these, while significant, will not be the focus of this project.

Instead, the focus and scope of this project revolves around the following two questions:

First, do female high school chemistry students show a higher level of achievement when taught by a female chemistry instructor than when taught by a male chemistry instructor? If the answer to this question is yes, then the leak may be caused by the gender of the teacher. If the answer is no, it may indicate that the gender of the teacher is not the cause of the "leak." This will be analyzed by use of students grades

because it provides the most objective measurement of student success available.

Second, do males achieve higher grades than females? If the answer is yes, it may be the cause for the higher proportion of males in chemistry careers. Success and high achievement generally breed additional interest.

To address these two questions, data was gathered from two groups of high school students: One group taught by a male and the other taught by a female.

COMMUNITY BACKGROUND

The sample group for this survey was drawn from a small community in Michigan. The entire county has a population of 30,605 [2] with a median age of 35.3 years. The total labor force consists of 15,063 people and has a three year average unemployment rate of 12.1%. [3] Average per capita income is $14,691.00. [4]

Table 1: The general employment groups, number of employees and the percentage of the total.

Employment Groups	Employees	%
Agriculture/Forestry/Fishing	97	0.6
Construction	805	5.3
Farm	510	3.4
Federal Government	30	0.9
Financial/Insurance/Real Estate	774	5.1
Manufacturing	2,463	16.4
Military/Civilian	72	0.5
Mining	26	0.2
Retail Trade	2,646	17.5
Services	3,495	23.2
State/Local Government	2,590	17.2
Transportation/Utilities	783	5.2
Wholesale Trade	672	4.5
Total	15,063	100.0

The county provides one public school system in which students are transported daily over an area of 620 square miles. [5]

During the school years of 1991-92, 1992-93, and 1993-94 an average of 5,742 students were enrolled in kindergarten through twelfth grade in the public school system. (Four parochial schools within the area have not been used in these summaries.) Ten elementary schools served an average of 3,026 pupils from kindergarten through sixth grade. One junior high school, containing grades seven and eight, averaged 947 pupils. The high school that contained grades, nine, ten, eleven and twelve, averaged 1756 pupils. [6]

CURRICULUM

The science curriculum at the high school studied required all students to successfully complete two full years of science. Ninth grade students were required to enroll in a year long class of physical science. Tenth grade students chose from four, year-long classes: Environmental Science 10, Basic Biology, Earth and Space Science, or Biology; or two semester courses, Introduction to Agriscience, Introduction to Forestry, or Plant and Animal Science. If they chose to continue in science, in the eleventh grade they took any of the previously offered required courses or chose from year-long Chemistry, Physics, or Advanced Biology; or a semester of Advanced Production Agriscience or Advanced Forestry. Advanced Chemistry or Agriscience Business Management were also available choices along with all previously mentioned courses for seniors.

Two years of chemistry were offered at the high school surveyed. The first year was simply called "Chemistry". The

students were introduced to topics such as nomenclature, stoichiometry, chemical reactions, gas laws and structure. Approximately eighteen laboratory activities were performed during each year (See Appendix A for the syllabus and laboratory activities). A grade of C or better in Algebra was the only prerequisite for this class.

The second year class, "Advanced Chemistry", introduced topics such as electrochemistry, thermochemistry, equilibrium, neutralization reactions, buffers and organic chemistry. Appendix B lists the materials and the laboratory activities for Advanced Chemistry. To qualify for Advanced Chemistry, the students must have achieved a "C" or better in Chemistry and have demonstrated the ability to use higher level thinking skills. The latter of these two requirements was based on the input of their Chemistry teacher.

CLASS COMPOSITE

The classes of Chemistry ranged from a high of twenty-six students per fifty-five minute period to a low of fourteen. A three year average was calculated to be twenty-one students per period. There were on average 57.5% female and 42.5% male students in these classes.

It is important to note that the students did not have a choice of which teacher they had for the chemistry classes. Scheduling was done by computer to avoid conflicts in staff, student and classroom scheduling. Students had a 59.1% chance of having a female teacher and a 40.1% chance of a male teacher. (Of the twenty-two chemistry classes taught between 1991 and 1994, the female taught thirteen and the male taught nine.)

COMPARISON OF THE MALE AND FEMALE TEACHER

The male teacher, being fifty years old, has taught in the same school system for the past twenty-five years, beginning his career in the 1968-1969 school year. He holds a Bachelor of Science Degree from Central Michigan University where he received a teaching certificate in the areas of math and chemistry and a Master of Science Degree in Secondary Administration. He taught math at the junior high school for eleven years before he accepted the opportunity to teach chemistry at the high school. He has been teaching chemistry for fourteen years.

The female teacher, twenty-eight years old, has taught chemistry for five years, four of those years have been at the school system used in this study. She received a Bachelors of Science Degree from Michigan State University (MSU) with a focus in biology and chemistry. Her teaching certification was from Ferris State University. She is currently fulfilling the

requirements for a Master of Science Degree in Physical Science at MSU.

During the years studied--1991-92, 1992-93, and 1993-94--the male teacher taught fifteen year long chemistry classes total: three Chemistry classes and two Advanced Chemistry classes per year. The female teacher taught fourteen year long chemistry classes consisting of five Chemistry classes in 1991-92, four Chemistry classes in 1992-93 and four Chemistry and one Advanced Chemistry class in the final year of the study.

Both teachers used the same textbook and performed the same laboratory activities. The units were taught to the two groups of students in the same order and the amount of time spent during each unit of study varied only a day or two per unit. The nature and personality of each teacher was different due to age and teaching experience.

To help evaluate the similarities and differences between the

instructors, twenty-three Advanced Chemistry students were asked to complete a survey during their seventh month of Advanced Chemistry. (Appendix C). Before completing the survey, a letter of explanation and introduction was sent to the parents of each student under the age of eighteen. Those students eighteen or older were given a copy of the same introduction letter to share with their parents. (Appendix D).

Out of the twenty-three who completed the survey, ten of them had both instructors, one for Chemistry, and the other for Advanced Chemistry.

The following comments came from six students who had the female teacher during their first year of Chemistry and the male teacher during Advanced Chemistry.

Table 2: Comments from students who had the female teacher for Chemistry and the male teacher for Advanced Chemistry.

Student	Female teacher/Chemistry	Male teacher/Advanced Chemistry
1	Fast paced with lots of concepts. The mood was kept light and somewhat interesting.	More scheduled and serious
2	I found it easier to comprehend things I was taught my first year. I liked this teachers teaching style better.	Too fast, not everyone learns and understands well or at the same pace.
3	Informative	Technical
4	Fun and energetic, a different style of teaching that I understood.	Straight forward, lots of equations and problems.
5	Good, tried to help students, made it interesting	Lectures are kind of boring but they help and I learn from them.
6	Too Fast	He takes time with you.

The following comments came from four students who had the male teacher during their first year of chemistry and were enrolled in Advanced Chemistry with the female teacher.

Table 3: Comments from students who had the male teacher for Chemistry and the female teacher for Advanced Chemistry.

Student	Male teacher/Chemistry	Female teacher/Advanced Chemistry
7	Organized and helpful.	Organized and helpful.
8	Disciplined and rigid, yet fun.	More relaxed but still effective.
9	Laid back, went at a pace that everyone could keep up with. (He) really cared if you learned the information.	Moved faster, I could still keep up. (She) cared if everyone was learning and gave us some choice in what we wanted to do.
10	Slow and very well explained	Very Fast

By reviewing the comments made by a number of students, I hold the impression that the male teacher was rather methodical and technical, whereas the female teacher was more sporadic and application orientated. This became apparent by a few specific comments from the students. Student #8 described the male teacher as "rigid" and the female teacher as "more relaxed". Other students used terms like "serious", "scheduled", "straight forward" to describe the male and terms like "informative", "energetic" and "effective"

to describe the female. Student #3 captured the essence of the two teachers by simply stating the female was "informative" and the male was "technical".

Surveys from students who had the male teacher for both Chemistry and Advanced Chemistry described his teaching style as "very structured" and "disciplined". Students who had the female teacher for both Chemistry and Advanced Chemistry described her style as "fast paced", "entertaining" and "informative". The descriptions of the two teachers styles do not appear to change between students who have had both teachers to those who have had same teacher for two years.

In December of 1994, a survey performed by the local school district analyzed how the 1993-94 graduates of the high school enhanced their secondary education. (146 of these students would have had chemistry in 1992-93). [7] Results are as follows:

Table 4: The categories, number of students and percentage of the total students for the graduates of 1992-93 are listed.

Categories	Students	%
Military	6	1.8
Trade school	1	0.3
College	137	40.2
College & job	77	22.8
Job	69	20.3
Unemployed	13	3.8
Foreign exchange	6	1.8
Moved from area	6	1.8
No answer/disconnected	16	4.7
Non graduates	17	5.0
Deceased	1	0.3
Graduates	340	100.0

Of the 340 graduates, 214 of them, 62.9%, continue to post secondary education. This correlates closely to the national average of 63%. [8] The material listed above was not broken into gender or field of study when it was collected, therefore, a comparison of females versus males continuing from high school to college can not be made.

DATA COLLECTION

There are many benefits of comparing two teachers from the same school. The student composite, background and teaching conditions are similar. Differences do exist, including personal teaching style and the learning environment, which are both established by the individual teacher.

The data collected for this study was tallied from official grades assigned by the instructors. It was originally categorized according to grade, gender of student, class period, year, and instructor. This proved to be insufficient because the two instructors used different grade scales. The following table (Table 5) shows the difference in the two instructors grading scales:

Table 5: Grade scale comparison of the female and male teacher.

Grade	Female Teacher percent	Male Teacher percent
A	93 -100	94 - 100
A-	90 - 92	90 - 93
B+	87 - 89	87 - 89
B	83 - 86	84 - 86
B-	80 - 82	80 - 83
C+	77 - 79	77 - 79
C	73 - 76	73 - 76
C-	70 - 72	70 - 72
D+	67 - 69	65 - 69
D	63 - 66	60 - 64
D-	60 - 62	55 - 59
E	0 - 59	0 - 54

A comparison of the two scales shows that the female teachers scale is a "straight" grading scale where the male teacher's scale tends to be more generous to students who are doing poorly (D+ and below) in the class. To establish accurate data for comparison the grade categories used in all the following tables were recalculated using the percentage assigned by the male instructor then transferred to the female teachers grading scale.

Only second semester grades were used because these represented students who had completed one full year of chemistry. There were six "special cases" where students were eliminated from the sample group. Four students were foreign exchange students and two students were enrolled in the second semester of Chemistry only.

The following tables show the number of students taught by the female teacher during the three school years studied. The tables separate the male and female students during each class period (2nd hour, 3rd hour...) according to grades. Again, the grading scale of the female teacher was used.

Table 6: Number of students, separated by gender, grades and class period taught by the female teacher during 1991-92.

FEMALE STUDENTS

Grades	2nd Hr	3rd Hr	4th Hr	5th Hr	6th Hr	Total	% of TOTAL
A	0	1	0	2	1	4	4.00
A-	1	0	0	1	0	2	2.00
B+	1	1	0	0	1	3	3.00
B	3	3	2	1	2	11	11.00
B-	1	1	1	0	1	4	4.00
C+	0	0	0	2	3	5	5.00
C	1	3	2	1	4	11	11.00
C-	0	4	2	1	0	7	7.00
D+	2	0	0	1	0	3	3.00
D	1	1	2	1	0	5	5.00
D-	0	1	0	0	0	1	1.00
E	1	0	0	0	0	1	1.00
Total	11	15	9	10	12	57	57

MALE STUDENTS

Grades	2nd Hr	3rd Hr	4th Hr	5th Hr	6th Hr	Total	% of TOTAL
A	0	0	3	0	1	4	4.00
A-	0	0	0	2	0	2	2.00
B+	0	1	0	1	0	2	2.00
B	2	2	0	2	1	7	7.00
B-	3	0	1	0	0	4	4.00
C+	0	0	1	1	2	4	4.00
C	0	1	1	0	1	3	3.00
C-	2	1	0	1	1	5	5.00
D+	1	1	0	0	0	2	2.00
D	0	0	2	0	0	2	2.00
D-	1	1	1	1	0	4	4.00
E	0	1	0	3	0	4	4.00
Total	9	8	9	11	6	43	43

TOTAL STUDENTS	100

Table 7: Number of students, seperated by gender, grades and class period taught by the female teacher during 1992-93.

FEMALE STUDENTS

Grades	2nd Hr	3rd Hr	4th Hr	5th Hr	Total	% of TOTAL
A	1	2	0	1	4	4.82
A-	1	1	0	0	2	2.41
B+	1	0	1	4	6	7.23
B	1	1	0	1	3	3.61
B-	3	0	0	1	4	4.82
C+	2	1	2	1	6	7.23
C	0	2	0	3	5	6.02
C-	0	4	0	2	6	7.23
D+	2	0	1	1	4	4.82
D	2	1	1	2	6	7.23
D-	0	0	0	0	0	0.00
E	0	0	0	0	0	0.00
Total	13	12	5	16	46	55

MALE STUDENTS

Grades	2nd Hr	3rd Hr	4th Hr	5th Hr	Total	% of TOTAL
A	2	1	0	2	5	6.02
A-	1	1	0	0	2	2.41
B+	2	2	2	0	6	7.23
B	3	0	0	1	4	4.82
B-	1	1	1	0	3	3.61
C+	1	2	0	2	5	6.02
C	1	0	2	1	4	4.82
C-	0	0	1	0	1	1.20
D+	0	0	1	0	1	1.20
D	0	1	0	1	2	2.41
D-	0	0	1	1	2	2.41
E	0	1	1	0	2	2.41
Total	11	9	9	8	37	45

TOTAL STUDENTS	83

Table 8: Number of students, separated by gender, grades and class period taught by the female teacher during 1993-94.

FEMALE STUDENTS

Grade	3rd Hr	4th Hr	5th Hr	6th Hr	Total	% of TOTAL
A	0	2	0	0	2	2.74
A-	0	3	1	0	4	5.48
B+	2	0	0	2	4	5.48
B	0	3	0	1	4	5.48
B-	2	4	2	1	9	12.33
C+	0	0	3	0	3	4.11
C	1	2	0	1	4	5.48
C-	1	1	0	1	3	4.11
D+	2	0	3	0	5	6.85
D	1	0	0	1	2	2.74
D-	1	0	0	0	1	1.37
E	1	0	0	0	1	1.37
Total	11	15	9	7	42	58

MALE STUDENTS

Grade	3rd Hr	4th Hr	5th Hr	6th Hr	Total	% of TOTAL
A	0	0	0	1	1	1.37
A-	0	0	0	3	3	4.11
B+	1	0	0	2	3	4.11
B	0	0	0	1	1	1.37
B-	3	1	1	0	5	6.85
C+	1	1	0	1	3	4.11
C	3	1	3	0	7	9.59
C-	0	1	0	1	2	2.74
D+	1	0	0	0	1	1.37
D	2	1	0	0	3	4.11
D-	0	0	0	0	0	0.00
E	0	0	2	0	2	2.74
Total	11	5	6	9	31	42

TOTAL STUDENTS	73

The following three tables show the number of students taught by the male teacher during the years of the study. These tables separate the female and male students according to class period and grade. The grade listed was determined using the percentages recorded in the gradebook and the scale used by the female teacher.

Table 9: Number of students, separated by gender, grades and class period taught by the male teacher during 1991-92.

FEMALE STUDENTS

Grade	1st Hr	2nd Hr	4th Hr	Total	% of TOTAL
A	3	0	1	4	6.35
A-	1	1	0	2	3.17
B+	2	1	2	5	7.94
B	0	1	3	4	6.35
B-	0	0	1	1	1.59
C+	2	1	3	6	9.52
C	1	1	0	2	3.17
C-	0	1	0	1	1.59
D+	1	2	1	4	6.35
D	2	1	0	3	4.76
D-	0	1	0	1	1.59
E	0	1	0	1	1.59
Total	12	11	11	34	53.97

MALE STUDENTS

Grade	1st Hr	2nd Hr	4th Hr	Total	% of TOTAL
A	1	3	1	5	7.94
A-	2	0	1	3	4.76
B+	1	1	2	4	6.35
B	1	1	0	2	3.17
B-	1	1	0	2	3.17
C+	1	2	1	4	6.35
C	1	1	0	2	3.17
C-	0	0	0	0	0.00
D+	1	0	1	2	3.17
D	0	1	1	2	3.17
D-	1	1	1	3	4.76
E	0	0	0	0	0.00
Total	10	11	8	29	46.03

TOTAL STUDENTS	63

Table 10: Number of students, separated by gender, grades and class period taught by the male teacher during 1992-93.

FEMALE STUDENTS

Grade	1st Hr	3rd Hr	6th Hr	Total	% of TOTAL
A	2	2	0	4	6.35
A-	1	1	1	3	4.76
B+	0	0	1	1	1.59
B	2	3	2	7	11.11
B-	1	4	3	8	12.70
C+	1	2	4	7	11.11
C	2	2	1	5	7.94
C-	2	2	1	5	7.94
D+	0	2	0	2	3.17
D	0	1	0	1	1.59
D-	0	0	0	0	0.00
E	0	1	0	1	1.59
Total	11	20	13	44	69.84

MALE STUDENTS

Grade	1st Hr	3rd Hr	6th Hr	Total	% of TOTAL
A	0	2	1	3	4.76
A-	1	0	0	1	1.59
B+	0	0	1	1	1.59
B	2	0	0	2	3.17
B-	0	0	1	1	1.59
C+	0	1	2	3	4.76
C	1	0	1	2	3.17
C-	0	1	0	1	1.59
D+	0	0	0	0	0.00
D	0	1	1	0	0.00
D-	2	0	1	3	4.76
E	0	1	1	2	3.17
Total	6	6	9	19	30.16

TOTAL STUDENTS	63

Table 11: Number of students, separated by gender, grades and class period taught by the male teacher during 1993-94.

FEMALE STUDENTS

Grade	1st Hr	3rd Hr	6th Hr	Total	% of TOTAL
A	3	2	1	6	8.57
A-	0	3	3	6	8.57
B+	1	0	0	1	1.43
B	1	3	1	5	7.14
B-	1	2	2	5	7.14
C+	1	1	1	3	4.29
C	1	0	1	2	2.86
C-	1	1	0	2	2.86
D+	1	1	0	2	2.86
D	1	1	0	2	2.86
D-	1	0	0	1	1.43
E	0	0	2	2	2.86
Total	12	14	11	37	52.86

MALE STUDENTS

Grade	1st Hr	3rd Hr	6th Hr	Total	% of TOTAL
A	0	3	4	7	10.00
A-	1	2	0	3	4.29
B+	4	0	2	6	8.57
B	2	2	1	5	7.14
B-	0	1	1	2	2.86
C+	0	2	1	3	4.29
C	1	1	0	2	2.86
C-	0	0	0	0	0.00
D+	1	0	1	2	2.86
D	1	0	0	1	1.43
D-	2	0	0	2	2.86
E	0	0	0	0	0.00
Total	12	11	10	33	47.14

TOTAL STUDENTS	70

The following summary shows the number of female students (FS) and male students (MS) for both the female teacher (FT) and male teacher (MT) during the year. The female teacher had 145 female students and 111 male students. The male teacher had 115 female and 81 male students. A summation of the three years shows that 260 females and 192 males elected chemistry from a total of 452 students during the three year period.

Class data was analyzed to determine if female students achieve higher grades in Chemistry by having a female teacher. A Chi Square Test was done on the three years of data collected for this study.

Table 12: A summary, organized by gender of teacher, gender of student and grade for three years.

1991-92

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	4	4	4	5	17
A-	2	2	2	3	9
B+	3	2	5	4	14
B	11	7	4	2	24
B-	4	4	1	2	11
C+	5	4	6	4	19
C	11	3	2	2	18
C-	7	5	1	0	13
D+	3	2	4	2	11
D	5	2	3	2	12
D-	1	4	1	3	9
E	1	4	1	0	6
TOTAL	57	43	34	29	163

1992-93

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	4	5	4	3	16
A-	2	2	3	1	8
B+	6	6	1	1	14
B	3	4	7	2	16
B-	4	3	8	1	16
C+	6	5	7	3	21
C	5	4	5	2	16
C-	6	1	5	1	13
D+	4	1	2	0	7
D	6	2	1	0	9
D-	0	2	0	3	5
E	0	2	1	2	5
TOTAL	46	37	44	19	146

Table 12: Cont'd

1993-94

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	2	1	6	7	16
A-	4	3	6	3	16
B+	4	3	1	6	14
B	4	1	5	5	15
B-	9	5	5	2	21
C+	3	3	3	3	12
C	4	7	2	2	15
C-	3	2	2	0	7
D+	5	1	2	2	10
D	2	3	2	1	8
D-	1	0	1	2	4
E	1	2	2	0	5
TOTAL	42	31	37	33	143

TOTALS

FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
145	111	115	81	452

FT & MT/FS	FT & MT/MS	TOTAL
260	192	452

CHI SQUARE TEST

The Chi Square Test is a hypothesis test concerning the distribution of a population. Observed distribution frequencies of a specific population are compared to expected distribution frequencies of a general population. If the observed and expected frequencies are equal (95% or better in this case), the null hypothesis is not rejected. If the observed and expected are not equal (less than 95% in this case) the null hypothesis is rejected.

A null hypothesis is a hypothesis (or focus question) which is written as a negative statement. For example, one of the focus questions which was introduced in the purpose asks: "Do female chemistry students show a higher level of achievement when taught by a female chemistry instructor than when taught by a male chemistry instructor?" Once rewritten into the format of a null hypothesis it would read: "Female chemistry students do *not* show a higher level of achievement

when taught by a female chemistry instructor than when taught by a male chemistry instructor."

The observed frequencies calculated and reported in Tables 13, 14 and 15 are the actual number of female chemistry students taught by the female teacher, male students taught by the female teacher, female students taught by the male teacher, and male chemistry students taught by the male teacher and the grades these students earned during a three year period.

A bivariate table was established with grades representing one characteristic and the gender of teacher and gender of the student representing the other characteristic. [9]

The expected frequencies are the values that would be expected from a random sample of high school chemistry students. These random values or frequencies are calculated by considering the number of students who fall into a specific group, for example: female students taught by a female teacher, and the grade achieved (A, B, C...) compared to the

total number of students. More specifically, by dividing the product of the row and column totals from the Table of Observed Values (O.V.) by the total number of students:

$$\text{Expected Value} = \frac{\text{(O.V. Column Total*O.V. Row Total)}}{\text{Total Number of Students}}$$

Once the Expected Values are calculated, they are compared to the Observed Values. To perform the Chi Square analysis, Chi Square is calculated using the following equation:

$$\text{Chi Square} = \frac{\text{(Observed Value - Expected Value)}^2}{\text{Expected Value}}$$

The sum of the Chi Square cells is called the Calculated Chi Square Value. The Calculated Chi Square Value is compared to a Critical Value. The critical value is determined by the degrees of freedom, and the confidence level.

The degrees of freedom (d.f.) is dependent on the size of the bivariate table. It is calculated by determining the product of

the number of rows less one and the number of columns less one:

$$d.f. = (Rows-1)(Columns-1)$$

The confidence level is chosen by the experimenter. It represents the parameters of accuracy desired. In this case, a 95% confidence level was chosen. In other words, 95% of the observed population must fit within the expected population distribution in order to show that "Female chemistry students do *not* show a higher level of achievement when taught by a female chemistry instructor than when taught by a male chemistry instructor."

The Critical Value is a cut off point. If the Calculated Chi Square Value is above the Critical Value more than 5% of the data does not fit within the established parameters. If the Calculated Chi Square Value is below the critical value than less than 5% of that data does not fit with in the previously mentioned parameters.

Once the degree of freedom is calculated and the confidence level is chosen, the critical value may be found on a Chi Square Table in most elementary statistics textbooks.

Tables 13, 14 and 15 show the Observed Values and Expected Values for 1991-92, 1992-93 and 1993-94 respectively.

Table 13: Chi Square Table for 1991-92

Observed Values (O.V.)

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	4	4	4	5	17
A-	2	2	2	3	9
B+	3	2	5	4	14
B	11	7	4	2	24
B-	4	4	2	2	12
C+	5	4	6	4	19
C	11	3	2	2	18
C-	7	5	1	0	13
D+	3	2	4	2	11
D	5	2	3	2	12
D-	1	4	1	3	9
E	1	4	1	0	6
TOTAL	57	43	35	29	164

$$\text{Expected Values} = \frac{\text{(O.V. Clm Total * O.V. Row Total)}}{\text{Total Number of Students}}$$

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	5.91	4.46	3.63	3.01	17
A-	3.13	2.36	1.92	1.59	9
B+	4.87	3.67	2.99	2.48	14
B	8.34	6.29	5.12	4.24	24
B-	4.17	3.15	2.56	2.12	12
C+	6.60	4.98	4.05	3.36	19
C	6.26	4.72	3.84	3.18	18
C-	4.52	3.41	2.77	2.30	13
D+	3.82	2.88	2.35	1.95	11
D	4.17	3.15	2.56	2.12	12
D-	3.13	2.36	1.92	1.59	9
E	2.09	1.57	1.28	1.06	6
TOTAL	57	43	35	29	164

Table 14: Chi Square Table for 1992-93

Observed Values (O.V.)

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	4	5	4	3	16
A-	2	1	3	1	7
B+	6	6	1	1	14
B	3	4	7	2	16
B-	4	3	8	1	16
C+	6	5	7	3	21
C	5	4	5	2	16
C-	6	1	5	1	13
D+	4	1	2	0	7
D	6	2	1	2	11
D-	0	2	0	1	3
E	0	2	1	4	7
TOTAL	46	36	44	21	147

$$\text{Expected Values} = \frac{\text{(O.V. Clm Total * O.V.Row Total)}}{\text{Total Number of Students}}$$

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	5.01	3.92	4.79	2.29	16
A-	2.19	1.71	2.10	1.00	7
B+	4.38	3.43	4.19	2.00	14
B	5.01	3.92	4.79	2.29	16
B-	5.01	3.92	4.79	2.29	16
C+	6.57	5.14	6.29	3.00	21
C	5.01	3.92	4.79	2.29	16
C-	4.07	3.18	3.89	1.86	13
D+	2.19	1.71	2.10	1.00	7
D	3.44	2.69	3.29	1.57	11
D-	0.94	0.73	0.90	0.43	3
E	2.19	1.71	2.10	1.00	7
TOTAL	46	36	44	21	147

Table 15: Chi Square Table for 1993-94

Observed Values (O.V.)

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	2	1	6	7	16
A-	4	3	6	3	16
B+	4	3	1	6	14
B	4	1	5	5	15
B-	9	5	5	2	21
C+	3	3	3	3	12
C	4	7	2	2	15
C-	3	2	2	0	7
D+	5	1	2	2	10
D	2	3	2	1	8
D-	1	0	1	2	4
E	1	2	2	0	5
TOTAL	42	31	37	33	143

$$\text{Expected Values} = \frac{\text{(O.V. Clm Total * O.V. Row Total)}}{\text{Total Number of Students}}$$

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	4.70	3.47	4.14	3.69	16
A-	4.70	3.47	4.14	3.69	16
B+	4.11	3.03	3.62	3.23	14
B	4.41	3.25	3.88	3.46	15
B-	6.17	4.55	5.43	4.85	21
C+	3.52	2.60	3.10	2.77	12
C	4.41	3.25	3.88	3.46	15
C-	2.06	1.52	1.81	1.62	7
D+	2.94	2.17	2.59	2.31	10
D	2.35	1.73	2.07	1.85	8
D-	1.17	0.87	1.03	0.92	4
E	1.47	1.08	1.29	1.15	5
TOTAL	42	31	37	33	143

All A's, B's, C's, D's, and E's were consolidated for each school year in order to perform the Chi Square Test. These cells were combined in order to create a data set that fit the statistical requirements of the Chi Square Test. Specifically, no more than twenty percent of the cells may have a value of less than five. [9]

Table 16: Chi Square Test 1991-92

Observed Value (O.V.)

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	6	6	6	8	26
B	18	13	10	8	49
C	23	12	9	6	50
D	9	8	8	7	32
E	1	4	1	0	6
TOTAL	57	43	34	29	163

$$\text{Expected Values} = \frac{\text{(O.V. Clm Total * O.V. Row Total)}}{\text{Total Number of Students}}$$

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	9.09	6.86	5.42	4.63	26
B	17.13	12.93	10.22	8.72	49
C	17.48	13.19	10.43	8.90	50
D	11.19	8.44	6.67	5.69	32
E	2.10	1.58	1.25	1.07	6
TOTAL	57	43	34	29	163

Table 17: Chi Square Test 1992-93

Observed Value (O.V.)

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	6	7	7	4	24
B	13	13	16	4	46
C	17	10	17	6	50
D	10	5	3	3	21
E	0	2	1	2	5
TOTAL	46	37	44	19	146

$$\text{Expected Values} = \frac{\text{(O.V. Clm Total * O.V. Row Total)}}{\text{Total Number of Students}}$$

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	7.56	6.08	7.23	3.12	24
B	14.49	11.66	13.86	5.99	46
C	15.75	12.67	15.07	6.51	50
D	6.62	5.32	6.33	2.73	21
E	1.58	1.27	1.51	0.65	5
TOTAL	46	37	44	19	146

Table 18: Chi Square Test 1993-94

Observed Value (O.V.)

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	6	4	12	10	32
B	17	9	11	13	50
C	10	12	7	5	34
D	8	4	5	5	22
E	1	2	2	0	5
TOTAL	42	31	37	33	143

$$\text{Expected Values} = \frac{\text{(O.V. Clm Total * O.V. Row Total)}}{\text{Total Number of Students}}$$

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	9.40	6.94	8.28	7.38	32
B	14.69	10.84	12.94	11.54	50
C	9.99	7.37	8.80	7.85	34
D	6.46	4.77	5.69	5.08	22
E	1.47	1.08	1.29	1.15	5
TOTAL	42	31	37	33	143

Once consolidated, it was noted that the 1992-93 year and 1993-94 year still had more than twenty percent of the cells with a value of less than five. Therefore, all three years of data were compiled and a Chi Square Test was done on this table.

Table 19: Chi Square Test 1991-94

Observed Value (O.V.)

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	18	17	25	22	82
B	48	35	37	25	145
C	50	34	33	17	134
D	27	17	16	15	75
E	2	8	4	2	16
TOTAL	145	111	115	81	452

$$\text{Expected Values} = \frac{\text{(O.V. Clm Total * O.V. Row Total)}}{\text{Total Number of Students}}$$

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	26.31	20.14	20.86	14.69	82
B	46.52	35.61	36.89	25.98	145
C	42.99	32.91	34.09	24.01	134
D	24.06	18.42	19.08	13.44	75
E	5.13	3.93	4.07	2.87	16
TOTAL	145	111	115	81	452

$$\text{Chi Square} = \frac{\text{(Observed-Expected)}^2}{\text{Expected}}$$

GRADE	FT/FS	FT/MS	MT/FS	MT/MS	TOTAL
A	2.62	0.49	0.82	3.63	7.56
B	0.05	0.01	0.00	0.04	0.10
C	1.14	0.04	0.04	2.05	3.26
D	0.36	0.11	0.50	0.18	1.15
E	1.91	4.22	0.00	0.26	6.39
TOTAL	6.09	4.86	1.35	6.16	18.46

Calculated Chi Square Value = 18.46

Critical Value = 21.66

The Calculated Chi Square Value was 18.46 for 1991-94. The Critical Value was determined to be 21.03 for 12 degrees of freedom.

If the Calculated Chi Square Values would have been greater than the Critical Value of 21.03, the null hypothesis would be rejected, showing that the female chemistry teacher *does* have a greater effect on female students. However, the Calculated Chi Square Value is less than the Critical Value so the null hypothesis is not rejected. Therefore, grades and gender of the teacher and student are independent of each other at this particular school for these two teachers during the school years between 1991 and 1994.

One has the tendency or desire to focus on the outstanding cells, for example: Table 19 the Observed Values - cell 1 and the Expected Values - cell 1. It was observed that 18 female students taught by the female teacher received A's where 26.31 were expected to. Although this appears to show a significant difference, it is critical to remember each cell

represents one data point. The Chi Square Test is not designed to analyze individual cells, but to look at the significance of whole data sets by focusing on the sum of the individual Chi Square cells.

To confirm this, two other Chi Square Tests were performed. The previous table (Table 19) compares four characteristics: Female teacher and female students, female teacher and male students, male teacher and female students and the male teacher and male students. The next two tests separate the students into female and male categories, then compare the achievement with the female teacher and male teacher.

Table 20 focuses on the female students with the female teacher and female students with the male teacher. The null hypothesis: "Female students in the female chemistry teachers classes will not achieve higher grades than female students in the male chemistry teachers classes." The null hypothesis for Table 21 is: "Male students in the male teachers class will not

achieve higher grades than male students in the female teachers chemistry class."

Table 20: Chi Square Test for the female students grades

Observed Value (O.V.)

GRADE	FEMALE TEACHER	MALE TEACHER	TOTAL
A	18	25	43
B	48	37	85
C	50	33	83
D	27	16	43
E	2	4	6
TOTAL	145	115	260

$$\text{Expected Values} = \frac{\text{(O.V. Clm Total * O.V. Row Total)}}{\text{Total Number of Students}}$$

GRADE	FEMALE TEACHER	MALE TEACHER	TOTAL
A	23.98	19.02	43
B	47.40	37.60	85
C	46.29	36.71	83
D	23.98	19.02	43
E	3.35	2.65	6
TOTAL	145	115	260

$$\text{Chi Square} = \frac{\text{(Observed-Expected)}^2}{\text{Expected}}$$

GRADE	FEMALE TEACHER	MALE TEACHER	TOTAL
A	1.49	1.88	3.37
B	0.01	0.01	0.02
C	0.30	0.37	0.67
D	0.38	0.48	0.86
E	0.54	0.69	1.23
TOTAL	2.72	3.43	6.15

Calculated Chi Square Value = 6.15
Critical Value = 9.49

Table 21: Chi Square Test for the male students grades from the female and male teacher 1991-94.

Observed Value (O.V.)

GRADE	FEMALE TEACHER	MALE TEACHER	TOTAL
A	17	22	39
B	35	25	60
C	34	17	51
D	17	15	32
E	8	2	10
TOTAL	111	81	192

$$\text{Expected Values} = \frac{\text{(O.V. Clm Total * O.V. Row Total)}}{\text{Total Number of Students}}$$

GRADE	FEMALE TEACHER	MALE TEACHER	TOTAL
A	22.55	16.45	39
B	34.69	25.31	60
C	29.48	21.52	51
D	18.50	13.50	32
E	5.78	4.22	10
TOTAL	111	81	192

$$\text{Chi Square} = \frac{\text{(Observed-Expected)}^2}{\text{Expected}}$$

GRADE	FEMALE TEACHER	MALE TEACHER	TOTAL
A	1.36	1.87	3.23
B	0.00	0.00	0.00
C	0.69	0.95	1.64
D	0.12	0.17	0.29
E	0.85	0.05	0.90
TOTAL	3.02	3.04	6.06

Calculated Chi Square Value = 6.06

Critical Value = 9.49

The Calculated Chi Square Values are 6.15 for the female students with the female and male teacher, and 6.06 for the male students with each teacher. The are both less than the Critical value of 9.49, which was dependent on the degree of freedom and the confidence level. This demonstrates that the gender of the teacher and grade of the female students is independent and that the gender of the teacher and grades achieved by the male students are independent.

The above tests demonstrated that the grades achieved by both female and male students is independent of the gender of the teacher. The second area of concern that will be addressed in this paper is: "Is there a difference between male and female students with respect to grades in the chemistry class? Specifically, do males receive higher chemistry grades than females?"

Z-TEST

The Z-Test is used to perform a large-sample hypothesis test for population means. [9] The Z-Test, more simply stated, is used to calculate average values of a large population. Whereas, the Chi Square Test is used to test goodness of fit or distribution. The Z-Test in this study was used to compare the grade point averages that the female and male students earned in their chemistry class. Letter grades of A through E were converted to points ranging from a value of 0 to 4. This is necessary, as the Z-Test calculates means or numeric averages, therefore, could not utilize letter grades.

Table 22: Z-Test - Grade point averages of all female and male students from 1991 to 1994.

GRADE	G. PT.	FEMALE	MALE	TOTAL
A	4	24	25	49
A-	3.7	19	13	32
B+	3.3	20	22	42
B	3	34	21	55
B-	2.7	32	17	49
C+	2.3	30	22	52
C	2	29	20	49
C-	1.7	24	9	33
D+	1.3	20	8	28
D	1	19	12	31
D-	0.7	4	11	15
E	0	6	12	18
TOTAL		261	192	453

FEMALE
X=2.438
SD=0.942
n=261

MALE
X=2.425
SD=1.100
n=192

$$Z = \frac{\bar{X}_f - \bar{X}_m}{\sqrt{\frac{(SD_f)^2}{n_f} + \frac{(SD_m)^2}{n_m}}}$$

Z=0.0168
Critical Value = +/- 1.96

The mean grade for female students was 2.438 and male students was 2.425, which were both in the B-/C+ range. It is interesting to note that the average grades were very close, having a difference of 0.013.

The Z-Test demonstrated that the difference between these values is not significant. The Calculated Z Value was 0.0168, which falls between the critical values of +1.96 and -1.96 which demonstrates a 95% confidence level on a two tailed curve. If the calculated Z value was outside these parameters, then a significant difference in the grade point averages of males and females would have been concluded.

COMPARISON OF GRADES

The following table shows the percentage of male students and females students and the grades they received. It is interesting to note the number of males who have demonstrated excellence by earning an "A" (93%) is higher than females earning the same grade; 11.9% male students received "A's" and 7.6% female students received "A's". If the grade category is expanded to look at the percentage of female and male students to achieve "B+" (87%) or higher, then the percentages are 24.8 and 31.6 respectively. The differences in these percentages are significant.

Table 23: Comparison of percentage of female and male students per academic grade for 1991-94.

GRADE	GPA	# FEMALE	% FEMALE	# MALE	% MALE
A	4.0	20	7.63	23	11.92
A-	3.7	25	9.54	16	8.29
B+	3.3	20	7.63	22	11.40
B	3.0	29	11.07	20	10.36
B-	2.7	36	13.74	18	9.33
C+	2.3	30	11.45	22	11.40
C	2.0	29	11.07	19	9.84
C-	1.7	24	9.16	9	4.66
D+	1.3	25	9.54	14	7.25
D	1.0	16	6.11	12	6.22
D-	0.7	4	1.53	9	4.66
E	0.0	4	1.53	9	4.66
TOTAL		262	100	193	100

Consolidation of Grades

PERCENT	# FEMALE	% FEMALE	# MALE	% MALE
87 - 100	65	24.81	61	31.61
80 - 86	65	24.81	38	19.69
70 - 79	83	31.68	50	25.91
60 - 69	45	17.18	35	18.13
0 - 59	4	1.53	9	4.66
TOTAL	262	100	193	100

CONCLUSIONS

Two conclusions can be drawn from this study. First, there are no apparent differences in the achievement level of female students with either a female chemistry teacher or male chemistry teacher at this high school as demonstrated in Table 19.

It has been suggested that female students will achieve a higher rate of success with female science teachers rather than male teachers. [11] My data show that female students have demonstrated the same level of achievement, as measured by the grade earned in the class, with either a female or male chemistry instructor.

One reason for the comparable performance may be the way in which chemistry is taught by both instructors at this high school. A large quantity of time is devoted to cooperative hands-on learning and laboratory activities. These types of activities are believed to be confidence builders for women. A lack of confidence tends to hinder women in math and science. [11]

Second, the data collected show that the number of female students who receive high grades (87% and above) in chemistry at the high school used in this study is significantly less than the number of males who demonstrate the same level of achievement. See Table 23.

The grade point averages, over three years, for all female and male students in chemistry, were 2.44 and 2.43 respectively (Table 22). Even though the average grades were similar the break down of the number of students in each grade category was not equal. 24.8% of the female students received a grade of 87% or higher, and 31.6% of the male students achieved grades of 87% or better (Table 23). If the percentages from this one three year period studied are representative of a trend, it may explain why so few women remain in chemistry through college, graduate studies and their careers.

One reason that more males achieve high grades may be the student's age. They enroll in chemistry during the eleventh and twelfth grade. By this time they have been influenced by many

other teachers. Some elementary and junior high school teachers inadvertently discourage females at an early age. Studies from the mid 1980's have shown that math and science teachers make more eye contact with boys and pay more attention to them than girls. When female students give the wrong answer they often get sympathy while male students are challenged to find the correct answer. Girls are praised for their neatness and timeliness in completing experiments; boys are recognized for the scientific content of their work. [11]

The "Leak in the Pipeline" mentioned earlier may be due to the fact that females are not as successful at achieving high grades as their male counterparts in high school chemistry. This may discourage them to pursue post secondary studies and ultimately careers in a pure science field like chemistry. The lack of success is not due to the gender of the teacher but may be due to other factors like, unconscious discouragement by teachers earlier in their careers, discrimination and

stereotyping in educational institutions and in the work place, and family values involving marriage and children.

AFFECTS OF THIS STUDY

Probably the most important thing which will come from this study is the way in which my work with students and other staff members will be affected. Although I don't know how this will ultimately unfold, I intend to proceed with the following changes:

I believe that students must be introduced to chemistry at a younger age. They should have the opportunity to experience this topic as early as first grade. Project 2061, Benchmarks for Science Literacy, suggests that chemistry topics such as the description of matter could be introduced as early as kindergarten. [10] This may be difficult for teachers at these levels, due to their insufficient knowledge of the topic and the lack of resources and materials available to them. I plan to spend additional time with grade school and junior high school teachers aiding in the development of units suitable to all students at specific grade levels.

This project has also made me more aware of the female chemistry student. They may require different styles of teaching to help them understand the fundamental concepts of chemistry. It is my intent to define what areas and styles of teaching work the best for both male and female students. Through surveys, both formal and informal, I will attempt to gain an understanding of student's interests and needs to better equip themselves to pursue a chemistry-related career.

FUTURE STUDIES

There are a few issues that I find interesting, that remain yet unanswered. For example, are younger students affected by the gender of the teacher? If younger students are affected by the gender of the teacher we, as educators, administrators and parents, should consider analyzing how the gender does affect them and what actions to take to promote learning in the school environment.

Do male students achieve higher grades in science at all grade levels, or is there a certain grade level where female students scores are higher than males? If this is the case, when does the change occur? What factors promote a larger percentage of males to be successful in chemistry than females?

Do females process information differently than males? If they indeed are different, what factors influence these differences? If this question is answered, the way math and science is taught may be forever changed.

What number of potentially good female scientists are drawn away from this track by female dominated careers such as nursing? The statistics gathered which discuss women in science do not take in to account the number of females which are nurses and other careers which require an extensive amount of science. It would be interesting to be able to draw a comparison of the grades achieved by people in programs such as nursing to programs like chemistry.

I believe many of these areas are currently being studied, and am looking forward to reviewing data and suggesting changes in our own school district as a result of these studies.

APPENDICES

APPENDIX A

Chemistry Syllabus

Topics	Time
Metric Conversions	
Significant Figures	
Exponentional Notation	
Dimentional Analysis	
Sand, Salt and Iron Laboratory Activity	
Melting Point of a Pure Substance	3 Weeks
Atomic Structure	
Density Laboratory Activity	1 Week
Nomenclature	
Periodic Table	3 Weeks
Mole Theory	
Molarity	
Mole Theory Experiment	
Iron Filing Mole Laboratory Activity	
Percent Water in Epsom Salt Laboratory Activity	4 Weeks
Chemical Reactions	
The Decomposition of a common Substance	
(Epsom Salt) Laboratory Activity	3 Weeks
Stoichiometry	
Formation of a Precipitate Laboratory	
Activity	3 Weeks
Ionic and Net Ionic Equations	
Acid Strength Laboratory Activity	3 Weeks
Redox Reactions	
Christmas Laboratory Activity	4 Weeks

Gas Laws	
Extrapolation of Absolute Zero Through an Application of Boyles Law Experiment	
A Quantitative Investigation of the Reaction of Magnesium with HCl	5 Weeks
Calorimetery Laboratory	1 Week
Atomic Theory	
Quantum Mechanics	
Trends in the Periodic Table	
Active Metals Laboratory Activity	4 Weeks
Chemical Bonds	
Ionic Reactions Laboratory Activity	
Cation and Anion Laboratory Activity	4 Weeks
Developing a Scheme for Qualitative Analysis Laboratory Activity	
Unknown Compounds Laboratory Activity	3 Weeks

APPENDIX B

Advanced Chemistry Syllabus

Topics	Time
Dimentional analysis Metric Conversion	1 Week
Limiting Reagent Conservation of Matter Laboratory Activity Continuous Variation Laboratory Activity	3 Weeks
Molarity Normality Gram Equilavalent Gram Equilavalent Laboratory Activity Atomic Mass of an Unknown Metal Laboratory Activity	3 Weeks
Electrochemistry Electrochemical Cells Laboratory Activity Faraday Laboratory Activity	4 Weeks
Percent Composition Nomenclature Review Emperical Formula	1 Week
Chemical Kinetics Chemical Kinetics Laboratory Activity	2 Week
Rate Law	1 Week
Equilibrium Lechatier Laboratory Activity Beer's Law Laboratory Activity	4 Weeks

Acid and Base Reactions	
Neutrilization Laboratory Activity	
Quantitative Titration Laboratory	
Indicator Laboratory Activity	
pH of a Strong Acid Laboratory Activity	
pH of a Weak Acid Laboratory Activity	6 Weeks
Buffers	
Buffer Laboratory Activity	
Neutrilization of a Weak Acid Laboratory	4 Weeks
Review	
Unknown Laboratory Activity	
Hydrolysis Laboratory Activity	2 Weeks
Organic Chemistry	
Alcohol/Ester Laboratory Activity	8 Weeks

APPENDIX C

Advanced Chemistry Student Survey

Are you Male or Female?

How old are you?

Was your Science 9 (Physical Science) teacher Male or Female?

What do you remember most about your science 9 teacher or class?

Did you take Biology?

How would you describe the style of studying required to be successful in Biology?

Why did you choose to go on in science?

What was your last math class?

Was your math teacher male or female?

What was your favorite math class?

Why?

Was your Chemistry teacher male or female?

How would you characterize your Chemistry instructors teaching style?

Is your Advanced Chemistry teacher male or female?

How would you characterize their teaching style?

What do you intend on doing after high school?

What is your ultimate career goal?

APPENDIX D

September 1, 1994

Dear Parents,

Over the past several years I have been working on courses to fulfill the requirements of a Masters of Science degree through Michigan State University. Over the next nine months I will be completing my thesis project where I will be examining different ways to teach chemistry.

Through this process I will be using your childrens' course work, grades and comments to formulate conclusions about the success of these teaching styles.

Numerical data from class work and home work will be collected, and comments from interviews and weekly surveys will be used. Your child's name will not be used in the project and will remain confidential.

Michigan State University's policy requires me to get your acknowledgement of this process. If you have any questions please feel free to call me or my major professor. I may be reached at XXXXX High School (356-6161 ext. 311) or at home (354-4677). My major professor, Michael J. Kenney, Ph.D., may be reached at Michigan State University
(517 / 355-9715 ext. 223)

Sincerely,

Ellsen L. Diamond
Chemistry Instructor

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