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Original Paper

Gender Differences in Secondary School Students' Achievement in Chemistry in Samburu County, Kenya

Lomonyang Ekwam[1], Fred N. Keraro[1] & Joel K. Ng'eno[1]

[1] Department of Curriculum, Instruction & Educational Management, Egerton University, Kenya

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Abstract

The purpose of this study was to investigate the gender differences in secondary school students' achievement in chemistry. In addition, the study sought to identify the factors that contribute to gender differences in chemistry achievement to in order to enhance the provision of equal opportunities for the learning of chemistry and all other sciences in general to both boys and girls. Cross-Sectional study design under the descriptive survey research was used. The target population of the study comprised of all the secondary school chemistry students in both public and private secondary schools in Samburu county. The accessible population were all the form three chemistry students in the county. A sample of 286 students was selected from a population of 1,238 using stratified and simple random sampling techniques. Students' Chemistry Achievement Test (SCAT) and Students' Gender Interview Schedule (SGIS) were used to collect data. The data collected was analyzed using both descriptive and inferential statistics. The statistics derived included the analysis of percentages, mean, standard deviation, students' T-Test scores and Chi-Square Test (x^2 test) used to establish the relationship between culturally accepted gender roles and achievement in chemistry. The findings show that there was a statistically significant gender difference in chemistry achievement in favour of boys. As a result, boys' schools performed better than both girls' and co-educational schools. Boys had a high affinity and interest towards chemistry than girls. Also the culturally accepted gender roles had an effect on chemistry achievement. It is recommended that the Ministry of Education should initiate in-service programmes for teachers in science courses emphasizing on relevant scientific skills to empower teachers to provide learning opportunities that would reduce the gender differences and the effect of cultural factors known to enhance gender differences in the learning and achievement in chemistry. Curriculum developers and policy makers need to develop curriculum materials that would help to reduce the gender gap in learning and achievement.

Keywords

gender differencs, students' achievement, chemistry

1. Introduction

In the economically competitive environment in the developing Countries, education systems are expected to 'produce' an optimum number of technologically qualified personnel who are needed in the labour market. This has implications for the planning of the education system of each Country. There is also a proportionately higher demand for both female and male students as societies become more responsive to gender balance. In most countries and more particularly the developing countries. Many of the more prestigious and more highly paid jobs and careers are a preserve of men who have been trained in the science based programmes, such as medicine, engineering and technology (Irungu, 2019). It is also acknowledged that girls shy away from science courses offered in schools leading to the gender imbalance in science -based careers in favour of men (Nnamani, 2016).

The impact of gender on secondary school students' achievement in chemistry is not entirely clear. However, research suggests that Chemistry might be less closely associated with masculinity than Physics but more so than Biology. Girls tend to have more stronger attachment to biology hence selecting biology courses more frequently (Thomas, 2017). Boys have higher self-concepts in Physics hence being more likely to choose a Physics based career than girls (Dudovitz, 2017). In contrast, girls and boys seem to be equally interested in chemistry (Batyra, 2017a). Is chemistry, therefore, gender-neutral? This aspect or perspective needs further investigation. The aspect of gender is well placed in the perspective that takes into account students' cultural backgrounds (Palt, 2018). This is necessary because students' achievement in chemistry has been linked to their cultural backgrounds and also in the view that gender is a cultural construct (Ruschenpohler, 2019).

Optimizing the learning and achievement in science (and by extension chemistry) and at the same time narrowing the gender differentials in performance may eventually lead to greater economic efficiency within a system. In this process, students' achievement in science and career opportunities could be enhanced (Eren-Sisman, 2018). Several scholars have identified attitude related factors such as low self-esteem, poor self-concept, fear of success, cultural influence and lack of confidence as having an influence on girls' achievement in mathematics and the sciences (Ongeri, 2012). Therefore, the gender differences in students' achievement in chemistry can be attributed to psychological and social factors. Despite the spirited cultural knowledge awareness efforts, the influence of gender related factors in students' achievement in chemistry persist. Hence, there was a need to explore more on the gender differences in students' achievement in chemistry with a view of suggesting possible intervention strategies, hence the need for this study.

1.1 The Objectives of the Study

This study was guided by the following two objectives:

i. To determine whether there are gender differences in secondary school students' achievement in chemistry in Samburu county.
ii. To identify the cultural factors that may be contributing to gender differences in secondary school students' achievement in chemistry in Samburu county.

1.2 Hypotheses Tested

In order to achieve the objectives of the study, the following null hypotheses were tested.

Ho1: There is no statistically significant gender differences in secondary school students' achievement in chemistry in Samburu County.

Ho2: There is no statistically significant relationship between cultural factors contributing to gender differences and secondary school students' achievement in chemistry in Samburu County.

1.3 Conceptual Framework

The conceptual framework used in this study was based on the Cross- Cultural Theory presented by Barry (1969). To successfully adapt Barry's Cross-Cultural Theory, the conceptual model representation illustrated in Figure 1, was used to guide the study.

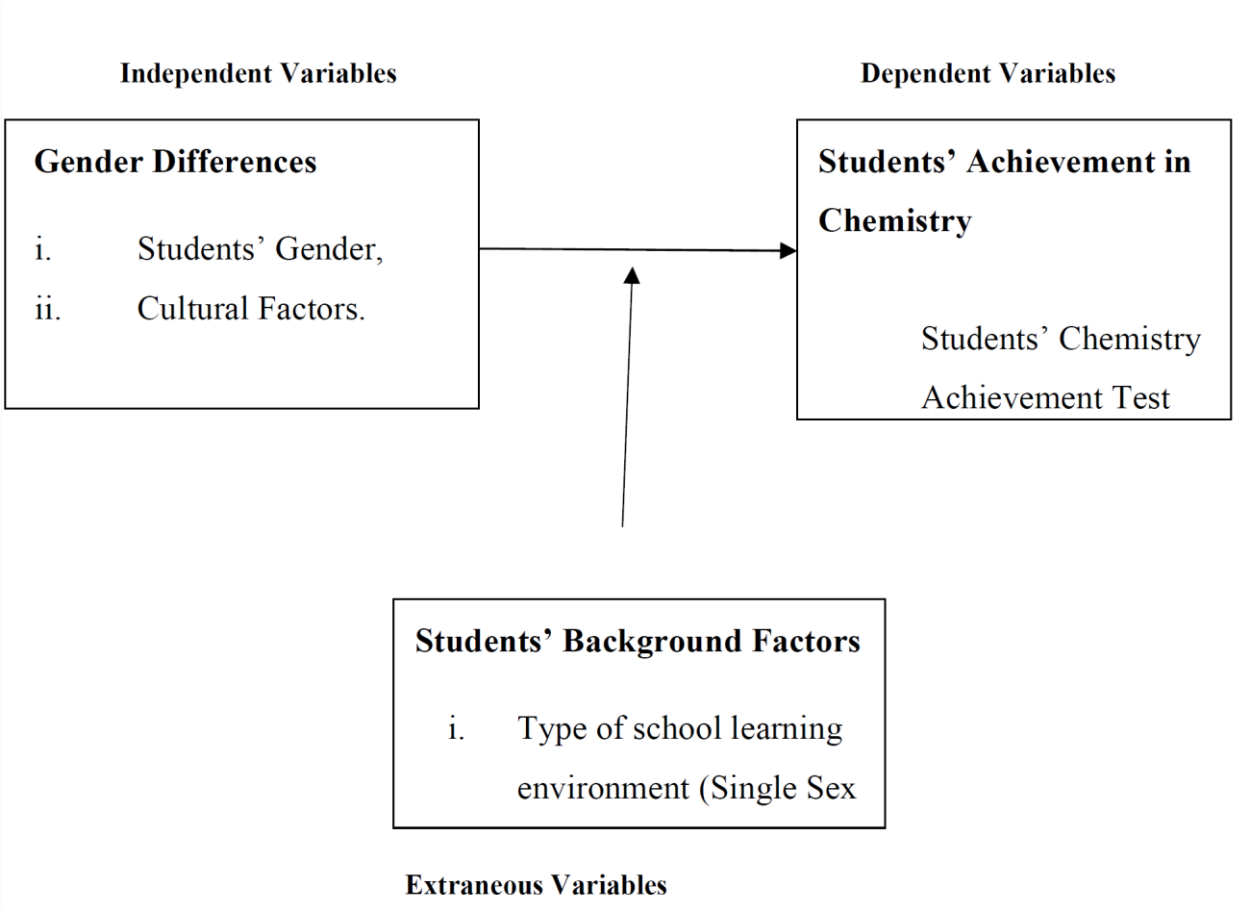

Figure 1. Conceptual Framework for investigating the Gender Differences in Students' Achievement in Chemistry

Figure 1 illustrates the conceptual framework that was used to guide the study. It has three main interrelated variables namely; independent, dependent and extraneous variables. The independent variables are students' gender and cultural factors while the dependent variable is the students' achievement in chemistry. Lastly the extraneous variables in this study are the type of school learning environment. Type of school learning environment was controlled by studying the performance of students in both public and private single sex and co-educational secondary schools.

2. Research Methodology

The study was a descriptive survey research, where cross-sectional study design was used. The design was relevant in this study for it would provide a way of obtaining facts and about opinions of individuals who would avail representative information about a larger population. In this way cross-sectional studies provide a 'snapshot' of the outcome and the characteristics associated with it at a specific point in time (Kuhn, 2014; Juma, 2014). The present study was aimed at determining whether there are gender differences in students' achievement in chemistry. The study, therefore, aimed at

analyzing the existing state of events, hence a cross-sectional study design being chosen because of the nature of the subject of inquiry in this study.

3. Sampling Procedures and Sample Size

The sampling units were the secondary schools. Cluster sampling technique was used to select nine secondary schools with adequate teaching/learning resources. The schools were visited to ensure that they were suitable for the study. Class lists were used as sampling frames and only students of the Samburu ethnic community were selected for the study. Stratified and simple random sampling was used in selecting boys and girls in single sex and mixed schools because it gave each unit in the population an equal opportunity to be involved in the sample (Kathuri & Pals, 1993). Nkapa (1997) argues that, there is no first hand rule for determining a sample size. However, in this study the expression, $n = Z^2 PqN$

$$(N-1)e^2 + Z^2Pq$$

was used in determining a sample size (n) as with Kothari (2004) method of sample size determination from a finite population as shown in appendix (V) where:

n = Required Sample Size,

Z = Value of Standard Variate =1.96 @ 95% Coefficient Interval (Cl),

N = The given Population Size (N = 1,238),

e = Acceptable Error and Degree of Accuracy (e = 0.05),

P = Proportionate Target Population with Particular Characteristics (P = 0.141),

q = 1- P = 0.859.

Using this formula, a sample size of 286 was proportionately selected which included 114 girls and 172 boys from nine secondary schools. Therefore, the minimum number of girls that were selected per school was 19, while on the other hand the minimum number of boys was 29. The total sample size selected is shown in Table 1.

Table 1. Selection of the Sample Size per School Type and Gender

School Type	Total no. of Schools	Total no. of Girls	Total no. of Boys	Total
Girls' schools	3	84	-	84
Boys' schools	3	-	109	109
Co-educational	3	30	63	93
Total	**9**	**114**	**172**	**286**

Source: Field Data, 2022

From the total sample of 286 in Table 3, 114 were girls and 172 were boys. This translated to 40 % and 60 % respectively. Cluster sampling was used to ensure that each category of schools was equitably selected for the study. Using cluster sampling technique, schools in each of the sub-Counties in Samburu County were grouped into a cluster, such that schools in every sub-County formed a separate cluster for easy of studying. Because of the homogeneity of the schools across the sub-Counties in the County, small size sub-Counties with one or two secondary schools were merged with large sub-Counties with many schools falling on the same side of the County, hence having two major sub-Counties which were Samburu North and Samburu Central. For the purpose of sampling, distribution of schools in each of the two major sub-Counties was based on the type of school category as shown in Table 2.

Table 2. Selection of School Category for Sample Size

School Type	Samburu North	Samburu Central	Total
Boys	1	2	3
Girls	2	1	3
Co-education	1	2	3
Total	**4**	**5**	**9**

Source: Field Data, 2022

The advantage of cluster sampling was that, it ensured the inclusion into the sample sub groups which otherwise would be omitted entirely by other sampling methods because of their low number in population (Mugenda & Mugenda, 1999). To ensure that all parts of the County would be represented, equal number of schools from each school type was selected randomly from each of the two major sub-Counties since most of the schools in Samburu County had one stream.

4. Data Collection and Analysis

To facilitate access into the school, a research permit was sought from the state agency that authorizes research in the Country, the National Commission for Science, Technology and Innovation (NACOSTI). The research instruments, the SCAT and SGIS were self-administered, where the respondents were asked to complete the SCAT by themselves and later subjected to interview guided by an interview schedule (SGIS). For accuracy and consistence of information, the respondents were given enough time to respond to items in both instruments on two different visits in each school.

The SCAT and SGIS were scored so as to generate both the quantitative and qualitative data respectively. Quantitative data generated by SCAT and the qualitative data generated by SGIS were analyzed using the T- test, Chi-square Test (X^2) test with the aid of Statistical Package for Social Sciences (SPSS) version 23.0 for windows (Kothari, 2004). Chi-Square Test (x^2 test) was used to

analyze the data collected using SGIS so as to check whether the frequency distribution of the respondents' responses fits into a specific pattern and also to establish the relationship between the variables. The Chi- Square test was useful in testing the homogeneity of proportions in a distribution. Data analysis involved use of hypothesis as a guide for analyzing data. To make reliable inferences from the data, all tests of significance were performed at a significance of Coefficient level of alpha (α) equal to 0.05.

5. Results

5.1 Results of Students' Chemistry Achievement Test (SCAT)

Students' Chemistry Achievement Test (SCAT) was administered on the all 286 students sat for the test. Data was collected, analyzed and presented in a tabular form using figures and the results are summarized in Table 3.

Table 3. Students' Chemistry Achievement per Sub- County (N= 286)

Sub-County	No. of Respondents	Mean (%)
Samburu North	115	28.90
Samburu Central	171	19.53
Total	286	23.64

Source: Field Data, 2022.

Results in Table 3 show that Samburu North Sub- County was on the lead with a mean of 28.90% while Samburu Central was second with a mean of 19.53% and this could be attributed to having few and adequately equipped schools in Samburu North Sub- County compared to Samburu Central. In the sampled schools, both boys and girls were involved in the study. The results of the Students' Chemistry Achievement Test (SCAT) scores per gender are presented in Table 4.

Table 4. Students' Chemistry Achievement Test (SCAT) Scores Per Gender (N= 286)

Gender	No. of Respondents	Mean (%)
Female	114	17.12
Male	172	26.80
Total	286	23.64

Source: Field Data, 2022

Results in Table 4 indicate that male students performed better than the female students as indicated by their respective means. This could be attributed to the general notion that sciences were for males and

not for females. Results of different school categories on students' achievement in chemistry administered are presented in a pie- chart shown in Figure 2.

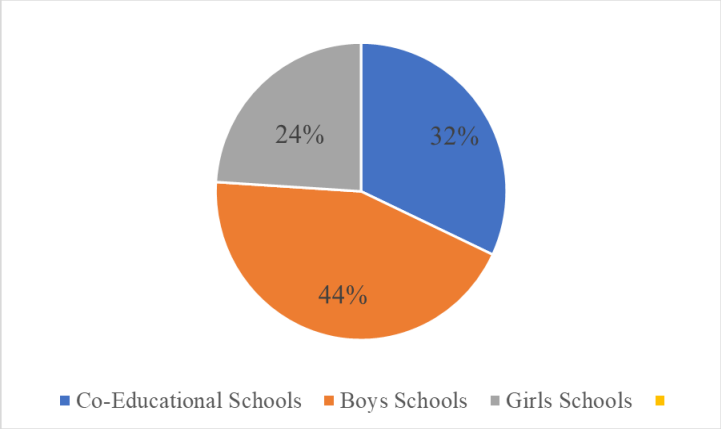

Figure 2. Pie-Chart of the different School Categories on Students' Chemistry Achievement Test (SCAT)

Figure 2 shows the results of the different school categories on students' chemistry achievement test (SCAT) scores. Boys schools were leading with a mean of 44% followed by co- educational schools- 32% and finally in the last position were the girls schools with a mean of 24%. Results for students' T–test value on SCAT scores are presented in Table 5.

Table 5. Students' T- Test Value on Students' Chemistry Achievement Test (SCAT) Scores (N= 286)

Gender	N	Mean Score	SD	SE of Mean	Mean Difference	t- Value	df	2- Tailed Sig.
Boys	172	28.20	14.554	1.110	11.43	7.278	284	0.000
Girls	114	16.77	10.205	0.956				

Significant at $\alpha = 0.05$

P- Value = 7.278, P > 0.05.

Source: Field Data, 2022.

Results in Table 5 show that the absolute t-value for gender differences in students' achievement in chemistry, 7.278 (P is less that 0.05 and thus is statistically significant. Thus, there was a statistically significant gender difference in students' performance in the chemistry achievement test. This could be attributed to the cultural expectations for boys and girls in the society.

5.2 Gender Differences in Students' Achievement in Chemistry

There is statistically significant relationship between gender differences and students' achievement in chemistry. Students' interview schedule was used to collect data on the gender differences in students' achievement in chemistry. A total of 30 students were interviewed. Data was collected, coded, analyzed descriptively and inferentially using the T-test and the Chi-Square (x^2) test. Data was presented in tabular form using figures. Results for the interviewed students' T– test value on SCAT scores are presented in Table 6.

Table 6. Students' T- Test Value for Gender Differences in Students' Achievement in Chemistry (N= 30)

Gender	N	Mean Score	SD	SE of Mean	Mean Difference	t- Value	df	2- Tailed Sig.
Boys	18	26.1667	19.1749	4.5196	14.6111	2.754	28	0.009
Girls	12	11.5556	11.7934	2.7797				

Significant at $\alpha = 0.05$

P-Value = 2.754, $P > 0.05$.

Source: Field Data, 2022.

From Table 6, it can be noted that , the absolute t-value for gender differences in students' achievement in chemistry, 2.754 ($P < 0.05$) is statistically significant. Thus, there was a statistically significant gender difference in students' performance in the chemistry achievement test. This could be attributed to societal or cultural expectations for boys and girls. As a result, the high rate of socialization brings about superiority of girls in descriptive tasks and vice versa. Results on how much some named gender factors related to students' achievement in chemistry are summarized in Tables 7.

Table 7. Relationship between Culturally Accepted Gender Roles and Students' Achievement in Chemistry (N= 30)

Response	No. of Respondents (N)	Frequency (f)	Percentage (%)
Yes	06	06	20
No	24	24	80
Total	30	30	100

Source: Field Data, 2022.

Results in Table 7 indicate that 80% of all the respondents interviewed cited that culturally accepted gender roles had no relationship to students' achievement in chemistry while 20% agreed.

Chi-Square (x^2) Test; $X^2 = \frac{\sum(O - E)^2}{E}$

Where; O = Observed frequency,

E = Expected frequency,

α= Level of significance set,

df = Degrees of freedom,

P = Critical/Probability value,

r = Calculated value.

$= \frac{(6- 15)^2 + (24-15)^2}{15} = 10.8$. α = 0.05, df = 1, P = 3.841, r = 10.8.

Since the r-value of 10.8 is much greater than P-value of 3.841, (r > p), indicates that the variables were highly related to one another and there was adequate evidence on their relationship hence rejection of the null hypothesis.

Results on the relationship between gender differences and students' achievement in chemistry are summarized in Table 8.

Table 8. Relationship between Gender Differences and Students' Achievement in Chemistry (N= 30)

Response	No. of Respondents (N)	Frequency (f)	Percentage (%)
Yes	23	23	77
No	07	07	23
Total	30	30	100

Source: Field Data, 2022.

Results in Table 8 indicate that 77% of the respondents interviewed agreed that gender differences was related to students' achievement in chemistry while 23% did not agreed. Therefore, based on the results in Table 8, the null hypothesis on the relationship between gender differences and students' achievement in chemistry is rejected.

Chi-Square (x^2) Test; $X^2 = \frac{\sum(O - E)^2}{E}$

Where; O = Observed frequency,

E = Expected frequency,

α= Level of significance set,

df = Degrees of freedom,

P = Critical/Probability value,

r = Calculated value.

$= \frac{(23-15)^2 + (7-15)^2}{15} = 8.533$. $\alpha = 0.05$, df = 1, P = 3.841, r = 8.533.

Since the r-value of 8.533 is greater than P-value of 3.841, (r > p), indicated that the variables were related to one another and there was sufficient evidence on their relationship hence rejection of the null hypothesis. Results for the main ways of managing gender differences in students' achievement in chemistry are presented in Table 9.

Table 9. Main Ways of Managing Gender Differences in Students' Achievement in Chemistry (N= 30)

Main Ways of Managing Gender Differences in Students' Achievement in Chemistry.	Frequency (f)	Percentage (%)
i. Sensitization of students on the gender differncs in students' achievement in chemistry.	10	33
ii. Use of guidance and counseling in Schools.	11	37
iii. Use of peer counseling among students in secondary schools.	09	30
Total	**30**	**100**

Source: Field Data, 2022.

Results in Table 9 show that 37% of the respondents agreed that guidance and counseling of students on gender differences in students' achievement in chemistry, sensitization of students- 33% and lastly use of peer counseling among students- 30% in secondary schools are the main ways of managing gender differences in students' achievement in chemistry in secondary schools.

6. Discussion

6.1 Results of Students' Chemistry Achievement Test (SCAT)

The results obtained reveal that, boy's schools performed better than girls and co-educational schools. From the results, boy's schools had a percentage of 44%, girl's schools with 24% and co-educational schools with 32%. The mean percentage for all boys sampled was 26.80%, and that of girls was 17.12%. The overall mean percentage for the whole sample was 23.64%. The general performance was below average as shown in Table 4. The findings of this study were consistent with those of Kigotho (2015) which indicated that, many students in Kenya choose to drop science subjects when given a choice and even for those who take them, the performance was below average. At this pont then, it was important to point out that students' background was a broad concept which comprised of very many factors and varied from community to community. This was for example perception towards education varied depending on the community. Poverty lowered the parent's ability to pay fees and purchase learning materials for their children (Ongeri, 2012). Gender was also another community based factor which condemned women to be married off at an early age before completing their education. This factor contributed to poor achievement in academics and also led to school dropout particularly at secondary school level (Irungu, 2019).

6.2 Gender Differences in Students' Achievement in Chemistry

The results of gender differences in students' achievement in chemistry as revealed in Tables 5 and 6, indicated that, the absolute t-values for gender differences in students' achievement in chemistry, 7.278 and 2.754 $P < 0.05$ respectively were significant. Thus, there was a significant difference between the gender of students and performance in chemistry achievement test. Also 20% of the respondents interviewed agreed that the culturally accepted gender roles were related to students' achievement in chemistry. Since the r-value of 8.533 was greater than P-value of 3.841, ($r > p$) as revealed in Table 8, indicated that the variables were related to one another and there was sufficient evidence on the relationship between gender differences and achievement in chemistry hence rejection of the null hypothesis. The findings concurred with those of Oluwatosin and Ogbeba (2017), which indicated that, the promotion of cultural methods of education and the inclusion of traditional knowledge also enabled those in Western post-colonial societies to re-evaluate the inherent hierarchy of knowledge systems.

The findings of this study on the main ways of managing gender differences in students' achievement in chemistry revealed that 37% of the respondents agreed that guidance and counseling, students' sensitization- 33% and peer counseling- 30% among students were the main ways used in secondary schools. The findings were consistent with those of Ruschenpohler (2019) and Leedy (2010), which indicated that, the cultural function of school science had traditionally been to enculturate or assimilate students into the new subculture of creativity in learning of sciences done through active class participation. This would help students' to understand clearly the relationship between gender and their achievement in chemistry. In the process, both students and teachers benefited from enhanced academic effectiveness, success and learning outcomes. Students and teachers would often have greater

awareness, respect and appreciated for the gender aspects and community in consequence of the context that was shared during the course of their educational pursuits.

7. Conclusion

Based on the findings of this study, the following conclusion was made:

i. Based on the aforementioned research findings, it can be concluded that, there is a positive correlation between students' gender and achievement in chemistry.

ii. Culturally accepted gender roles had an effect on students' achievement in chemistry.

8. Recommendations

On the basis of the results of this study, the following recommendations were made:

(a). Curriculum developers and policy makers need to develop curriculum materials that would help to reduce gender differences in students' achievement in chemistry and facilitate meaningful learning of chemistry and also improve students' achievement in chemistry and other sciences.

(b). The Ministry of Education should initiate in-service programmes for teachers in science courses emphasizing on relevant scientific skills to empower teachers to provide learning opportunities that would minimize the effect of cultural factors known to promote the establishment of gender differences in chemistry achievement.

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