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Influence of School Characteristics on the Achievement of Secondary School Chemistry Students in the Cognitive Science process Skill of Evaluation in Kenya

Zephania O. Anditi[1], Mark, I.O. Okere[1*], and Daniel R. Muchiri[2]

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

E-mail: Okeremark836@yahoo.com

Chemistry is one of the subjects that students sit for in the Kenya Certificate of Secondary Education (KCSE). The attainment of students in chemistry in KCSE has been quite low. An analysis of the past Chemistry examination papers taken in KCSE reveals that the papers test students' competencies in various aspects of Cognitive Science Process Skill of Evaluation (CSPSE). It was hypthesised that school characteristics could be influencing students' acquisition of various aspects of CSPSE. The school characteristics investigated were social set up (single – sex and co- educational schools) and school location (rural and urban schools). The aspects of CSPSE investigated were: reformulation of scientific statements, evaluation of experimental procedures, evaluation of inferences from scientific data, and evaluation of scientific arguments. Cross- sectional survey research design was used in this study. Cognitive Science Process Skills Test (CSPST) was constructed and administered to a stratified random sample of 386 Form Three Chemistry students drawn from Public County Secondary Schools in Rift Valley Province of Kenya. Analysis of variance (ANOVA) was used to analyze the data. Hypotheses were tested at $\alpha = 0.05$ level of significance. The findings of the study show that students from single-sex secondary schools performed significantly better than their counterparts from co-educational schools in all the categories of CSPSE that were investigated. The school location did not have a significant influence on students' performance on CSPSE. The findings of this study are expected to inform the education planners and teachers of the influence of school characteristics on students' performance on CSPSE.

Keywords: influence, school characteristics, cognitive science process skill, evaluation, achievement

Introduction

Chemistry is one of the Science subjects that are essentinal for the development of any country. Fensham (1984) asserts that a country cannot have a strong scientific and technological enterprise without a base in chemical education. Twoli (2006) argues that chemical knowledge is useful in many areas of modern life such as: food production and preservation, production of medicines/drugs for management of diseases, and development of favourable habits such as intellectual honesty, diligence, perseverance, and objective observation. According to Wachanga (2005) Chemistry occupies a central position among the traditional secondary school science subjects namely, Physics and Biology. It has a

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two way exchange with Physics and Biology producing two interlinking equilibria which make a significant contribution to liberal education.

Despite the importance of Chemistry in the curricula of Secondary Schools in various countries, the achievement of students in the subject is quite poor. For instance, a review of the achievement of students in Chemistry at the West African Senior School Certificate Examination (WASSCE) established that the failure rate in the subject has been quite high (Agbodeka, 2002). According to Usman and Memeh (2007) factors such as students' background, students' lack of interest, and lack of qualified teachers, large classes, inadequate instructional materials, and application of poor teaching methods contribute to students' poor achievement in Chemistry.

In Kenya, the achievement of students in chemistry in the Kenya Certificate of Secondary Education (KCSE) has been quite poor over the years. Annual KCSE examination reports by the Kenya National Examinations Council (KNEC) show that the mean scores attained by students in chemistry in KCSE have been considerably below 29% over the last six years – 2006 to 2011 (KNEC, 2007, 2008, 2009, 2010, 2011, 2012). According to KNEC grading system, 29% is the minimum score required for a pass (grade D) in a Science subject in KCSE. Table 1 presents students' performance in Chemistry in KCSE for the period 2006 to 2011 inclusive.

Table 1. Performance of Secondary School Students in KCSE Chemistry between 2006 and 2011

Year	Mean Scores (out of 200)	SD	Mean Scores (%)	SD
2006	49.82	32.00	24.91	16.00
2007	50.78	31.00	25.39	15.50
2008	45.48	31.78	22.74	15.89
2009	38.23	24.53	19.12	12.27
2010	49.79	31.57	24.90	15.79
2011	47.31	33.51	23.66	16.76

Source:Kenya National Examinations Council, KCSE Annual reports, 2007, 2008, 2009, 2010 , 2011and 2012

Table 1 shows that the mean score in chemistry in KCSE has been below 25.5% for the period, 2006 to 2011. Thus the majority of students who take chemistry in KCSE do not perform well in the subject. The poor performance of students in chemistry is a worrying trend, taking into account the fact that a high percentage of KCSE students take chemistry as illustrated in Table 2.

Table 2 shows that for the six year period more than 90% of the total candidature for KCSE opted for Chemistry annually. This is a very high percentage taking into account the fact that the achievement of students in Chemistry in KCSE is quite poor. The mismatch between high enrolment of students for Chemistry in KCSE and poor achievement in the subject requires an investigation. Chemistry is not a compulsory subject in KCSE and as such it would be expected that since the performance of students in the subject is poor, many students would not be attracted to it in KCSE. However, the importance of Chemistry in modern life seems to drive many students to take it even if their achievement in it is quite poor. It is therefore necessary to explore ways of improving the achievement of students in Chemistry in KCSE so that when they get to post-secondary institutions they may be able to pursue courses whose prerequisites require good grades in Chemistry in KCSE.

Table 2. Number and Percentage of KCSE Chemistry Candidates between 2006 and 2011

Year	Total Number of KCSE Candidates	Number and Percentage of Candidates who Sat for Chemistry	
		No.	(%)
2006	243,453	236,831	97.28
2007	276,239	267,719	96.92
2008	305,015	296,937	97.35
2009	337,404	329,730	97.73
2010	357,488	347,364	97.17
2011	411,738	403,070	97.89

Source: Kenya National Examinations Council, KCSE Annual reports, 2007, 2008, 2009, 2010, 2011, and 2012.

Science Process Skills

Science Process Skills are activities which contribute to students' achievement in Science (Watson, 1987). They are activities in which students get involved for the purpose of learning Science. Wray, Freeman, Campbell, Clarke, and Driver (1987) provide a total of fifteen Science Process Skills. The examples of Science Process Skills given by Wray et al. (1987) include planning, hypothesizing, experimenting, observing, classifying, interpreting, evaluating, and inferring. Similar examples of Science Process Skills are given by other researchers (Carin & Sund, 1980; Keil, Haney & Zoffel, 2009; Chabalengula, Mumba & Mbewe, 2012). Science Process Skills are generally divided into two categories: Cognitive Science Process Skills and Psychomotor Science Process Skills (Kempa, 1986). Cognitive Science Process Skills are process skills which are concerned with students' intellectual abilities. Examples of such process skills are planning, hypothesizing, interpreting, evaluating, and predicting. Psychomotor Science Process Skills, on the other hand, are those that relate to practical activities, these include: experimenting, observing, classifying and recording (Kempa, 1986; Anderson,2002).

In this study the researchers focused on theCSPSE. The choice of the CSPSE was because the analysis of the KCSE Chemistry examination papers revealed that the examinations not only tested students' knowledge and mastery of chemical facts, concepts and principles, but also their ability to assess chemical information and arrive at answers through logical reasoning. Thus, the test items in KCSE Chemistry examinations require students to be competent in the skill of evaluation of chemical information. Taking into consideration the fact that Kenya Secondary Schools do not possess uniform characteristics, the researchers found it necessary to carry out a study aimed at finding out how school characteristics influence students' competencies in the CSPSE. The following four categories of the CSPSE were identified: reformulation of scientific statements, evaluation of experimental procedures, evaluation of inferences from experimental data, and evaluation of scientific arguments.

Reformulation of scientific statements aimed at assessing students' ability to recognize testable and non-testable scientific statements. Thus, students were presented with scientific statements which were framed in such a way that they were either too vague or too general to be checked through experimental investigations. They were required to reformulate the statements so that they could be testable. Evaluation of experimental procedures on the other hand, aimed at assessing students' ability to make correct choice of apparatus for particular experimental investigations. It also tested students' ability to recognize the correct sequence of steps in carrying out an experiment, and also their ability to identify the variables that need to be controlled in an experiment. Evaluation of inferences from experimental data focused on the competencies of students in making judgment in regard to the possible inferences that could be made from a set of experimental data. Thus, students were given sets

of data derived from experimental investigations and for each set of data possible inferences were given. Students were expected to judge each inference and indicate whether or not it was correct and to justify their responses. Finally evaluation of scientific arguments focused on students' ability to determine the fallacies in various scientific arguments. In this respect students were presented with scientific arguments based on concepts or principles which they come across in chemistry lessons. They were expected to examine the arguments and decide whether or not they were valid, and then justify their responses.

The four categories of CSPSE highlighted in this paper are based on the objectives of Kenya Secondary School Chemistry course (Kenya Institute of Education [KIE], 2002). The objectives include, among others, developing students' ability to reason critically in any given situation, and also to enable them to select appropriate apparatus for experimental practices.

School Characteristics

Kenya secondary schools have varying characteristics which may impact either positively or negatively on students' achievement. In this study the researchers sought to find out the influence of two school characteristics on the achievement of students on CSPSE. The school characteristics investigated were school social set up and school location. School social set up refers to the composition of a school with regard to the gender of students. Thus, schools are categorized as either single-sex schools or co-educational schools. Single-sex secondary schools may be either for boys (that is, boys' only schools) or for girls (girl's only schools). On the other hand, co-educational secondary schools (also known as mixed-sex schools) admit both boys and girls, and this enables students of both sexes to learn in the same environment.

The type of social set up in a school is likely to have profound influence on the way students learn, and ultimately on their achievement in examinations. Annual KCSE examination reports by the Kenya National Examinations Council (KNEC) (2009, 2010) indicate that students from single-sex secondary schools achieve higher grades in chemistry than their counterparts from co-educational secondary schools. Babendreier (2004) found that students who are in single-sex secondary schools are often more confident and more willing to participate in learning tasks in the classroom compared to their counterparts who are in co-educational institutions. Ormerod (1981) posits that students from co-educational secondary schools do get quite stressed during classroom interactions since they often have to make efforts to impress their colleagues of opposite sex. This implies that students in co-educational schools are often under a lot of pressure even when responding to teachers' questions during classroom lessons. This implies that classroom learning atmosphere in co-educational schools is not quite free as compared to classroom learning atmosphere in single-sex schools. Thus students in co-educational secondary schools are often distracted by their colleagues of opposite sex, and this interferes with their willingness to carry out classroom learning tasks. This view is supported by Kelly (1981), Rudd (1984) and Onah and Ugwu (2010) in findings of research studies focusing on sex differences in achievement of students.

School location is another characteristic of Kenya Secondary Schools which is likely to influence students' achievement in academic work. In Kenyan Secondary School education set up there are schools which are located in urban areas and those that are in rural areas. The former category of schools is referred to, in this study, as Urban Secondary Schools, and the latter category are referred to as Rural Secondary Schools. Since the study targeted co-educational secondary schools, the categories of schools are denoted as Co-educational Urban (Co-ed [U]) and Co-educational Rural (Co-ed[R]) secondary schools respectively. Students who learn in Urban Secondary Schools are generally those whose parents work in those urban centres. The parents may be engaged in either formal or informal employment. On the other hand, students who learn in Rural Secondary Schools are generally those whose parents may not be engaged in formal employment. The majority of such parents may be engaged in various activities ranging from peasantry to small scale economic enterprises. Thus, the parents or guardians of students who learn in Rural Secondary Schools are generally less economically

endowed compared to the parents of students who learn in Urban Secondary Schools. Research findings show that the achievement of students is influenced by their socio-economic background (Casanova, Garcia-Linares, Torre, & Carpio, 2005; Owoeye & Yara, 2011). These findings are supported by Brownell, Roos, and Fransoo (2006) who established that socio-economic status of parents influences the academic competence of students: students from more economically endowed households usually display better academic achievement than their counterparts from poor families.

Purpose and Objectives of the Study

The purpose of the study was to investigate the influence of school characteristics on the achievement of secondary school Chemistry students in the skill of evaluation. The study was guided by the following objectives:

i. To determine the influence of the school social set up on the achievementof chemistry students on the skill of evaluation.
ii. To determine the influence of school location on the achievement of chemistry students on the skill of evaluation.

Hypotheses

The following hypotheses were tested:

H_o1: There is no statistically significant difference in achievement in the skill of evaluation between students from different school social set ups (single- sex schools and co-educational schools).

H_o2: There is no statistically significant difference in the achievement in the skill of the evaluation, between students from co-educational school (rural) and those from co-educational (urban) secondary schools.

Methodology

Cross-sectional survey research design was used in this study. Wierma(1995) points out that cross-sectional research design can be used to collect data at one point in time for random sample representing a population. The research design is thus used to determine the nature of prevailing conditions and relate them to the practices that exist within the population at that point in time. This research design was found to be appropriate for the study since it could provide data on the effect of school characteristics on the performance of chemistry students on the skill of evaluation at a point in time when the students were about to proceed to their final year of secondary school studies.

The target population consisted of Form Three students following KCSE chemistry course in Provincial Public Secondary School in Rift Valley Province of Kenya. The accessible population comprised Form Three students following KCSE chemistry course in Provincial Public Secondary Schools in Nakuru, Kericho, Uasin Gishu and Nandi counties in Rift Valley Province. The sampling procedure used to arrive at the sample for this study consisted of three main stages: selection of counties in Rift Valley Province, to be used in the study; selection of secondary schools; and selection of individual respondents. The choice of counties whose schools participated in the study was purposive. Nakuru, Kericho, Uasin Gishu and Nandi counties were purposively selected because, put together, they had about half the number of Municipal and Town Councils in Rift Valley Province (Central Bureau of Statistics, 2004). These municipal and town councils in the four counties provided a total of 26 Provincial Public Co-educational (urban) secondary schools from which a random sample of four secondary schools of this category was selected. Furthermore, the counties provided a good number of other types of Provincial Public Secondary Schools (single-sex secondary schools and co-educational (rural) secondary schools) from which secondary schools of these categories were selected.

Stratified random sampling was used to select the Provincial Public Secondary Schools that participated in the study. The schools were stratified into four categories: Boys' schools, Girls' schools, Co-educational (rural) schools, and Co-educational (urban) schools. Four secondary schools of each category were randomly selected from three research zones. This gave a sample of 376 students. Table 3 gives the number of boys and girls from each type of school who participated in the study.

Table 3 . Break-down of the number of Boys and Girls from each type of Secondary Schools, who participated in the Study

Type of Schools	Number of Boys	Number of Girls	Total
Boys Schools	66	-	66
Girls Schools	-	64	64
Co-Educational (Rural) Schools	64	66	130
Co-Educational (Urban) Schools	63	63	126
Total	193	193	386

Chemistry teachers in the participating schools assisted in selecting of the Form Three students who took part in the study. The teachers were requested to supply the researchers with class lists of their Form Three chemistry students and a Table of Random Numbers (Wallen & Freankel, 2002) was used to select the participants.

The instrument used to collect data was Cognitive Science Process Skills Test (CSPST). The instrument was constructed by the researchers. The instrument was pilot tested in three schools in Nakuru County. The schools used for piloting were not included in the sample frame during the main study. Reliability of the instrument was computed using Cronbach's alpha formula. Alpha co-efficient obtained was 0.75. According to Wallen and Fraenkel (2002) a co-efficient alpha of 0.70 is considered suitable and indicates that the instrument is sufficient reliable for use in research. Hence Cognitive Science Process Skills Test (CSPST) was considered to be suitable for study.

Data collection involved administering the instrument, CSPST, to the sampled students in each of the 16 secondary schools in the four counties in Rift Valley Province. The researchers administered the test to the respondents in those schools in a span of two weeks, assisted by chemistry teachers teaching Form Three Classes in the sampled schools. Descriptive and inferential statistics were used to analyse the data.

Results

The performance of students from different types of secondary schools in the various categories of the skills of evaluation is shown in Table 4.

Table 4. Mean$(\bar{X})$, standard deviations (SD), standard errors of the means $(S_{\bar{X}})$, and the 95% confidence intervals of the scores obtained by students from different types of secondary schools in various categories of the skill of evaluation

Category of the Skill Evaluation	Type of School	Number of Students	$\bar{X}$ (%)	SD	$(S_{\bar{X}})$	95% Confidence interval for mean	
						Lower Bound	Upper Bound
Category A (Reformulation of Scientific Statement	Single-sex	130	44.28	12.87	1.13	42.07	46.49
	Co-ed (R)	130	25.67	11.50	1.01	33.69	37.65
	Co-ed (U)	126	27.28	11.08	0.99	25.34	29.22
Category B (Evaluation of experimental procedures	Single-sex	130	36.97	12.30	1.08	34.85	39.09
	Co-ed (R)	130	25.77	11.38	1.00	23.81	27.73
	Co-ed (U)	126	26.09	8.73	0.78	24.56	27.62
Category C (Evaluation in inferences from experimental data)	Single-sex	130	39.33	11.38	1.00	37.37	41.29
	Co-ed (R)	130	31.11	10.36	0.91	29.33	32.89
	Co-ed (U	126	31.15	12.54	1.12	28.96	33.35
Category D (Evaluation of Scientific statements)	Single-sex	130	31.59	15.26	1.34	28.95	34.22
	Co-ed (R)	130	21.20	10.93	0.96	19.32	23.08
	Co-ed (U	126	17.91	10.30	0.96	16.11	19.71
CCSE (Combined categories of the skill of evaluation)	Single-sex	130	38.04	11.14	0.98	36.12	39.96
	Co-ed (R)	130	28.44	9.88	0.87	26.73	30.15
	Co-ed (U	126	25.61	8.22	0.73	24.18	27.04

Test of significance (ANOVA-One way) was carried out in order to determine whether or not the difference in attainment between students from different types of secondary schools in various categories of the skill of evaluation were statistically significant. The results of ANOVA (One way) are shown in Table 5.

Table 5. ANOVA (One way) of the scores obtained by students from different types of secondary schools in various categories of cognitive science process skill of evaluation

Category of the skill of Evaluation	Source of Variance	Sum of Squares	Df	Mean Square	F	Sig. Level
Category A (Reformulation of Statement)	Between groups	18490.143	2	9245.07	23.470*	.000
	Within Groups	150865.993	383	393.906		
	Total	169356.076	385			
Category B (Evaluation of experimental procedures)	Between groups	10521.487	2	5260.744	14.770*	.000
	Within Groups	136416.357	383	356.178		
	Total	146937.844	385			
Category C (Evaluation of inferences from experimental data)	Between groups	5795.979	2	2897.990	7.651*	.000
	Within Groups	145069.974	383	378.773		
	Total	150865.953	385			
Category D (Evaluation of scientific statement	Between groups	13123.463	2	6561.731	15.900*	.000
	Within Groups	158059.443	383	412.688		
	Total	171182.906	385			
CCSE (Combined categories of the skill of evaluation)		10937.496	2	5468.748	33.170*	.000
		63144.940	383	164.869		
		74082.436	385			

(*) Significant at the 0.05 level

Table 5 shows that the attainment of students, from different types of secondary schools, in each of the categories significant ($p<0.05$, ANOVA – one way). Post hoc tests, using Fisher's Least Significant Difference (LSD) were carried in order to determine the pairs of groups of students whose differences in attainment in specific categories of the skills of evaluation were statistically significant. Table 6 gives a summary of the results of the post hoc tests.

Table 6 shows that students from single-sex schools (SS) performed significantly better than their counterparts from both co-educational (rural) [Co-ed(R)] and co-educational (urban) [Co-ed(U) secondary schools in all the categories of the skill of evaluation. They also performed significantly better than their counterparts in the combined categories of the skill of evaluation. On the other hand, the difference in attainment between students from co-educational (rural) secondary schools and their counterparts from co-educational (urban) secondary schools was statistically significant in only one category of the skill of evaluation – that is, Category A of the skill of evaluation, which focused on Reformulation of Scientific Statements. In the rest of the categories of the skill of evaluation there were no statistically significant differences in attainment between students from the two types of co-educational secondary schools.

Table 6. Fisher's LSD test to determine the pairs of types of secondary schools in which the attainment of students in the respective categories of the skill of evaluation are significantly different

Category of the skill of Evaluation	Mean $\bar{X}$ (%)	Type of school and Mean difference			
		Type of School	SS	Co-ed (R)	Co-ed (U)
Category A (Reformulation of Scientific Statement)	44.28	SS	-	8.61*	17.00*
	35.67	Co-ed(R)	-8.61*	-	8.39*
	27.28	Co-ed(U)	-17.00*	-8.39*	-
Category B (Evaluation of experimental procedures)	36.97	SS	-	11.20*	10.88*
	25.77	Co-ed(R)	-11.20*	-	-0.32
	26.09	Co-ed(U)	-10.88*	0.32	-
Category C (Evaluation of inferences from experimental from data)	39.33	SS	-	8.22*	8.18*
	31.11	Co-ed(R)	-8.22*	-	-0.04
	31.15	Co-ed(U)	8.18*	0.04	-
Category D (Evaluation of scientific statements)	31.59	SS	-	10.39*	-13.68*
	21.20	Co-ed(R)	-10.39*	-	3.29
	17.91	Co-ed(U)	-13.68*	-3.29	-
CCSE (Combined categories of the skill of evaluation)	38.04	SS	-	9.60*	12.43*
	28.44	Co-ed(R)	-9.60*	-	2.83
	25.61	Co-ed(U)	-12.43*	-2.83	-

Discussion

The purpose of the study was to find out whether school characteristics such as the social set up of the school (single sex and co-educational) and school location (rural and urban) had significant influence on the attainment of chemistry students in the cognitive science process skill of evaluation. Tests of significance showed that there were significant differences in the attainment of students from the different types of secondary schools in all the categories of the skill of evaluation. Post hoc tests (Fisher's LSD) showed that in all the categories of the skill of evaluation, students from single-sex secondary schools performed significantly better than their counterparts from co-educational secondary schools. The superior performance posted by students from single-sex schools in the skill of evaluation may be attributed to several factors. These include active participation in chemistry lessons and exposure of laboratory work. Research studies show that students from single-sex secondary schools participate more actively in chemistry lessons than their counterparts from co-educational secondary schools (Johnson &Letton, 1990). The better exposure to laboratory work may be a contributing factor to the attainment of students from single-sex schools in the skill of evaluation. This is in agreement with the findings by a number of researchers (Gott & Duggan, 1996; White, 1996) that exposure to laboratory work has a positive influence on the performance of students in chemistry.

A comparison of the attainment of students from co-educational (rural) secondary schools and that their counterparts from co-educational (urban) secondary schools showed that there was no statistically significant difference in the attainment of these groups of students in all the categories of the skill of evaluation except in category A (Reformulation of Scientific Statements). In this category of the skill of evaluation students from co-educational (rural) secondary schools performed significantly better than those from co-educational (urban) secondary schools. Reformulation of scientific statements required students to make precise scientific statements out of vague statements such that the re-stated statements could be testable. It is not clear why students from schools in rural set up outperformed their counterparts from schools in urban set up in only this category of the skill of evaluation. In the other categories of the skill of evaluation the performance of students from co-educational (rural) and those from co-educational (urban) secondary schools bore no statistically significant difference.This is in agreement with the findings of Beaumont-Walters and Soyibo (2001), and Onah and Ugwu (2010)The findings of this study are therefore not conclusive in regard to the influence of school location on the attainment of chemistry students on the skill of evaluation. However, it is essential to point out that apart from displaying significantly better achievement in category A of the skill of evaluation (Reformulation of scientific statements), students from co-educational (rural) schools had higher mean score than their counterparts from co-educational (urban) schools in category D of the skill of evaluation (Evaluation of Scientific statements). This category of the skill of evaluation was theoretical in nature and required students to display in-depth mastery and understanding of various chemical concepts so as to be able to detect any fallacies in the scientific arguments focusing on the concepts. On the other hand, students from co-educational (urban) schools posted slightly higher mean scores than their counterparts from co-educational (rural) schools in Category B (Evaluation of experimental procedures) and Category C (evaluation of Data from experiments) of the skill of evaluation. These two categories of the skill of evaluation were experiment-oriented.

These findings are in agreement with the findings of Ngesa (2002). In a study of the impact of Mastery Learning Programme on the achievement of secondary school students in Agriculture, Ngesa established that students who learnt agriculture under mastery learning programme in rural schools scored significantly higher than their counterparts who learnt under the same programme in urban schools. However, in a study focusing on the impact of Experiential Learning Programme on the achievement of students in Agriculture, Ngesa reported that students in urban secondary schools attained higher mean scores than students from rural secondary schools, although the difference in attainment between the two groups of students was not statistically significant.

Conclusion

Schools characteristics exert a significant influence on the attainment of secondary school students in theCSPSE. Students from single-sex secondary schools were found to display better attainment in the skill of evaluation than their counterparts from co-educational (rural) and co-educational (urban) secondary schools. In regard to school location, students from co-educational (rural) secondary schools were found to display significantly better attainment in the category of the skill of evaluation which involved concepts that were not experiment-oriented, whereas students from co-educational (urban) performed better in categories of the skill of evaluation that involved experiment-oriented concepts. The superior achievement of students from urban schools in the categories of CSPSE which were expemental in nature could be attributed to better facilities for science learning that are in urban schools.

Implications of the findings

The findings of the study have several implications:

(i) One of the implications of the findings of the study is that secondary school chemistry teachers hardly draw students' attention to the importance of the Cognitive Science Process Skill (CSPS) of evaluation. Thus, although students in single-sex schools posted better attainment, than their counterparts in co-educational schools, in the various categories of the skill of evaluation, the level attainment they displayed was quite low.

(ii) Students in all three (3) types of secondary schools {single-sex, co-educational (rural) and co-educational (urban)} posted very poor level of performance in Category D of the skill of evaluation. This category of the skill of evaluation focused on students' competence in identifying fallacies in scientific arguments. In this regard, the problems raised in this category required students to have effective mastery and understanding of the scientific concepts on which the scientific arguments were based. Hence poor attainment of students in this category of the skill of evaluation implies that generally many students lacked competence in basic chemical concepts such as solubility, mole, pH, and molarity.

(iii) The attainment of students form co-educational (rural) was generally better than that of their counterparts from co-educational (urban) in categories of the skill of evaluation that were not experiment-oriented. On the other hand, the attainment of students from co-educational (rural) was worse than that of their counterparts from co-educational (urban) in experiment-oriented categories of the skill of evaluation (categories B and C). This implies that there is imbalance between chemistry theory and chemistry practical work in co-educational (rural) schools, with more emphasis being laid on the former and the expense of the latter.

Recommendations

- Curriculum developers should include objectives and learning activities that focus on developing aspects of the CSPS of evaluation.
- Chemistry teachers should emphasize the various aspects of the science process of evaluation during chemistry lessons.
- Teachers in both single- sex and those in co-educational schools should give equal opportunities for the students to develop the science process skills of evaluation.

Suggestions for Further Research

- There is need to use a larger sample in order to check the generalizability of the findings from this study.
- Similar studies could be conducted to check if the findings are applicable to other science subjects.
- There is need to check if achievement on CSPS of evaluation is gender dependent.

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