Effect of Ethnochemistry Practices on Secondary School Students' Attitude Towards Chemistry

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Abstract
The main purpose of the study was to find out the effect of ethnochemistry practices on secondary school students' attitude towards Chemistry. The design of the study was pre-test post-test control group quasi-experimental design. Two grade 11 intact classes were assigned into experimental and control groups randomly. The total sample size comprised 113 students. To assess attitude of the student towards Chemistry, a chemistry attitude questionnaire was used. An independent samples t-test at an alpha (α) = .05 was conducted to analyze the results of the pre-test and post-test scores. There was a statistically significant difference in the post-test attitude scores for control (M=74.71, SD=13.90) and experimental (M=83.36, S=14.68) groups; t (111) = -3.22, p = 0.002. Therefore, incorporating ethnochemistry practices in teaching chemistry was found to have a positive effect on enhancing secondary school students' attitude towards Chemistry.
Keywords: Ethnochemistry, Conventional approach, Attitude

1.0 Introduction

The importance and value of chemistry in the social and economic sphere of any nation is immense and, Zambia is not an exception. The knowledge and skills inthis central science is utilised in almost all the sectors of economy. Chemistry enables students to understand what happens in the world they live in and how it contributes to the quality of life on our planet (Ware, 2001). Chemistry curricula incorporate many abstract concepts, which are central to further learning in both chemistry and other sciences (Taber, 2002).

Because of the critical role of chemistry in the social and economic life of a nation, the teaching of chemistry should be done in such a manner that students have deep understanding and liking for it. However, research shows that chemistry is generally a difficult subject to students at all levels (O'dwyr, 2012). This is also reflected in the poor performance of students in chemistry. For instance, the 2014 Examinations' Performance Report (EPR) of the Examinations Council of Zambia reported generally poor performance in Chemistry 5070 examinations. Poor performance of pupils in Chemistry could also be ascribed to learner's attitude and conception towards the subject in addition to many other factors. There is a great agreement among science theorists and practitioners on the importance of students‟ attitude toward chemistry lessons in school. In the same vein, Steiner and Sullivan (1984) pointed out that there was a relationship between students' perceptions and attitudes towards chemistry course and their course achievements. Pupils may have negative tendencies and pessimism towards chemistry due to the bad experiences that they have had with the subject (Johnstone, 2006). However, there have been ongoing endeavours to explore and implement several possible interventions to improve students' attitude in Chemistry. One of such interventions is to teach the subject beginning from what the student already knows. This brings about meaningful learning (Gregory & Mayer, 2002). The inclusion of knowledge related to ethnochemistry practices may instill a sense of ownership about the concept and improve the attitude of students in chemistry

It seems Africa in general, and Zambia in particular is lost due to following foreign curricular. Reminding us of the African proverb "When lost, it's better to return to a familiar point before rushing on", Ki-Zerbo stresses "Africa is in serious trouble, not because its people have no foundations to stand on, but because ever since the colonial period, they have had their foundations removed from under them" (Gerdes, 2014: 10). This is probably particularly true in the case of chemistry and maybe other sciences as well. Students seeing Chemistry as an alien subject, presents one of the principal challenges to African chemistry educators. Inclusion of ethnochemistry practices in lessons may bring a sense of ownership of the subject.

Ethnochemistry are the various chemically related cultural and community practices. It describes the chemical practices of identifiable cultural groups and may be regarded as the study of chemical ideas found in any culture. For instance, when defining ethnomathematics, D'Ambrosio (Rosa &Orey, 2011) defined the prefix ethno as a very broad term that refers to the social-cultural context and therefore includes language, jargon, and codes of behavior, myths, and symbols. In other words, ethno refers to members of a group within a cultural environment identified by their cultural traditions, codes, symbols, myths, and specific ways used to reason and to infer (Rosa &Orey, 2011).

Many Zambian students and teachers experience chemistry as a rather strange subject, imported from outside Africa. In order to overcome this psychological and cultural blockage to the learning and development of chemistry, the Zambian chemistry traditions and practices may be 'incorporated' into the chemistry lessons in order to improve students' attitudes towards chemistry. Marasinghe (2013) was able to introduce a Unit in the Grade 11 and 12 Chemistry Syllabus under the title 'Traditional Chemical Practices'. Further, incorporating ethnochemistry in chemistry lessons may enable students to veal chemistry as a familiar subject, and not one that is strange imported from outside Africa.

Indeed, these indigenous chemically related practices may be used to make the unfamiliar chemistry content familiar to students. For example, fermentation of corn or maize grains in traditional production of Kachasu (alcohol) may be used when teaching the production of ethanol by fermentation in Organic Chemistry. The distillation phase in the same ethno chemical practice may be used when teaching students distillation technique of separating a liquid from a soluble solid. Additionally, traditional practice of blacksmithing can be used when teaching extraction of iron in the blast furnace. Further, the traditional process of making table salt (sodium chloride) can be used when teaching the preparation of soluble salts such as zinc sulphate from zinc granules and dilute sulphuric acid, and can also be used when teaching filtration technique of separating an insoluble solid from a liquid. Furthermore, charcoal burning knowledge can be used when teaching complete and incomplete combustion.

This study attempted to find out the effect of some ethnochemistry practices on secondary school students' attitude towards chemistry. The study incorporated the ethnochemistry knowledge relevant to some selected topics such as filtration, distillation, preparation of soluble salts, and extraction of iron in lessons. There is a dearth of information on ethnochemistry in Zambia. After careful literature survey, there did not seem to be any study done on the effect of ethnochemistry practices on students' attitude towards chemistry in Zambia or elsewhere. Therefore, it would be novel and quite interesting idea to study the effect of incorporating ethnochemistry practices in chemistry lessons on students' attitude in Chemistry.

2.0.0 Methodology

2.1.0 Research Design

According to Tichapondwa (2013: 114), a research design "is a plan or strategy which moves from the underlying philosophical assumptions to specifying the selection of respondents, the data gathering techniques to be used and the data analysis to be done". The design of this study was a mixed methods design. Mixed methods design combines both quantitative and qualitative research and methods in a research study (Creswell, 2008: 189). Documenting the ethnochemistry practices was done qualitatively using unstructured interviews whereas finding out the effects of ethnochemistry practices on students' attitudes towards Chemistry was pre-test post-test control group quasi-experimental design. The pre-test allowed to assess whether the groups were equivalent on attitude towards Chemistry before the treatment was given to the experimental group. This is consistent with what Sherri (2009: 323) wrote: "a pre-test allows us to assess whether the groups are equivalent on the dependent measure before the treatment is given to the experimental group". This design facilitated to assess any changes that may have occurred in each group after treatment by comparing the pre-test measures for each group with their post-test measures.

Structure of the quasi-experimental design that was used in this study

The experimental group studied the filtration, distillation, preparation of soluble salts and extraction of iron content of the Chemistry 5070 syllabus integrating ethnochemistry knowledge. The control group studied the same content without incorporating relevant ethnochemistry knowledge in chemistry lessons.

The following was the structure of the pre-test post-test quasi experimental design that was used in this study.

O_1	X	O_2
O_1	$-$	O_2

Where:

O_1 were the observations that were made during the pre-test measures. Both the experimental and control groups were given a Chemistry Attitudes Questionnaire as pre-test measure.

X was the treatment that was employed in order to assess its effects on students' attitude towards Chemistry. The experimental group was taught filtration, distillation, preparation of soluble salts and extraction of iron through the integration of relevant ethnochemistry knowledge in chemistry lessons. The treatment combined indigenous with formal school chemistry content. On the other hand, the control group was taught using conventional approach.

O_2 were the observations made during the post-test. Both the experimental and control groups were given the Chemistry Attitudes Questionnaire as post-test measure. Then comparisons were made between pre-test and post-test attitude within groups and between groups. It was deduced that the treatment was the cause of any significant difference in attitude towards chemistry.

2.2.0 Target Population

The population of this study included all grade eleven pupils at Buyantanshi Secondary School in Mufulira district of Zambia. Further, certain people in the community were included in the study in order to learn and document ethnochemistry practices from them.

2.3.0 Sample and Sampling Procedure

Two classes at Buyantanshi Secondary School were purposively selected to be the research subjects. One class represented the experimental group, and the other class constituted the control group. Grade 11S1 consisted of 55 students, whereas grade 11M1 consisted of 58students. The subjects of the study were not randomized into experimental and control groups but were left as intact classes. This was to avoid the disruption of the school programmes. However, the classes were assigned into experimental and control groups randomly.

2.4.0 Construction of Chemistry Attitudes Questionnaire

Attitude of students towards Chemistry, was assessed using a Chemistry Attitude Questionnaire. The items in the questionnaire were developed by 'brainstorming' a small sample of 20 students. This involved getting the students to list as many facets of their attitude towards chemistry as possible. These students were selected on the basis of them having either high liking or low liking of chemistry subject. This was done on the belief that it would enable the construction of questionnaire items that span the entire spectrum of chemistry attitudes intended to be measured (Field, 2003: 04).

To avoid response bias, that is, the tendency of respondents to give the same answer to every question, items were reverse-phrased (Field, 2003). Further, these items were scored in reverse when entering the data into SPSS. Once the questionnaire items were written, their order was randomised. The questionnaire having 50 items was produced, and 320 photocopies were piloted to 303 students from the other six classes that were not part of the control or experimental groups, in order to refine the questionnaire.

After piloting the questionnaire, data was entered into SPSS by having each item represented by a column in SPSS. The response scale was translated into numbers (i.e., 5 point Likert, for positively stated items the scoring was 5 = Strongly agree, 4 = Agree, 3 = Neither agree nor disagree, 2 = Disagree, 1 = Strongly disagree). Negatively phrased items were scored in reverse (appendix).

Before running factor analysis, it was important to eliminate any items in the questionnaire that were not useful, and reduce the number of items further. This was done by looking at descriptive statistics. According to Field (2003), ideally each item in the questionnaire should elicit a normally distributed set of responses across subjects (each items Mean should be at the centre of the scale and there should be no skew). Therefore, to check for items that produced skewed data, the researcher looked for the skewness and standard error skew (SE skew) in the SPSS output. The skewness was divided by its standard error (SE skew) to form a z-score. According to Field (2003), if after dividing the skew by its standard error and the absolute value is greater than 1.96, then the skew is significant. This enabled the researcher to eliminate all items that were significantly skewed. Twenty one (21) items were found to be significantly skewed and were eliminated from the analysis.

After conducting a Varimax rotation, twenty four (24) items were included in the Chemistry Attitudes' Questionnaire (CAQ).The Chemistry Attitudes Questionnaire was used both in the pre-test and post-test without changes.

3.0.0 Results of the Study

3.1.1 Pre-test Results

3.1.2 Pre-test Attitude Results

The attitude questionnaire responses were analysed and the outcome summarized in tables as follows. The attitude mean and standard deviation were calculated from transformed scores in order to show the relative attitude mean on the five point Likert scale.

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Table 1: Control Group Pre-test Responses (N=58)

	STATEMENT	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE	ATTITUDE MEAN	STD DEVIATION
		PERCENTAGE						
1	Students who learn chemistry can behave normally	3.4	12.1	13.8	43.1	27.6	2.21	1.088
2	Chemistry has done more harm than good to humans	17.2	53.4	19.0	6.9	3.4	3.74	.947
3	I would like to become a Chemist when I complete secondary school education	3.4	17.2	12.1	58.6	8.6	2.48	.995
4	Chemists do not have leisure time to spend with their families	1.7	12.1	24.1	46.6	15.5	2.38	.952
5	It is wise to spend money buying chemistry materials and resources	15.5	50.0	20.7	10.3	3.4	3.64	.986
6	It would be boring to work as a chemist	5.2	15.5	13.8	56.9	8.6	2.52	1.030
7	People who study chemistry look like any other people	5.2	6.9	17.2	44.8	25.9	2.21	1.072
8	Chemists make harmful discoveries	22.4	50.0	19.0	5.2	3.4	3.83	.958
9	Working in a chemistry laboratory would be interesting	5.2	15.5	13.8	55.2	10.3	2.50	1.047
10	Studying chemistry makes you unfriendly to other people	1.7	13.8	24.1	46.6	13.8	2.43	.957
11	Chemistry knowledge makes life better	20.7	44.8	20.7	13.8	0.0	3.72	.951
12	A career prospect in chemistry would be boring	3.4	19.0	13.8	53.4	10.3	2.52	1.030
13	People who study chemistry can be athletic like other people	3.4	6.9	13.8	43.1	32.8	2.05	1.033
14	There are other secondary school subjects which are more important than chemistry	24.1	44.8	15.5	12.1	3.4	3.74	1.069
15	I would like to become a teacher of chemistry	1.7	15.5	13.8	53.4	15.5	2.34	.983
16	People who study chemistry do so only to earn a living	0.0	15.5	24.1	48.3	12.1	2.43	.901
17	Chemistry helps in making our planet a better place to live in	17.2	44.8	17.2	19.0	1.7	3.57	1.045
18	I wouldn't become a Chemist because it is a difficult field	1.7	19.0	15.5	53.4	10.3	2.48	.978
19	People who study chemistry are as fit and healthy as others	3.4	8.6	13.8	50.0	24.1	2.17	1.011
20	Money spent on chemistry materials and chemicals is just wasted	19.0	44.8	20.7	12.1	3.4	3.64	1.038
21	It would be interesting to work as a chemist	0.0	15.5	12.1	53.4	19.0	2.24	.942
22	Chemists are untidy	1.7	17.2	24.1	44.8	12.1	2.52	.978
23	Chemistry is one of the most interesting subjects in school	17.2	50.0	19.0	10.3	3.4	3.67	.998
24	I wouldn't like to work in a chemistry laboratory after completing school	3.4	15.5	12.1	63.8	5.2	2.48	.941
	Average	8.2	25.4	17.2	37.7	11.4	2.81	.3921

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Table 2: Experimental Group Pre-test Responses (N=55)

	STATEMENT	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE	ATTITUDE MEAN	STD DEVIATION
		PERCENTAGE						
1	Students who learn chemistry can behave normally	3.6	10.9	14.5	41.8	29.1	2.18	1.090
2	Chemistry has done more harm than good to humans	16.4	52.7	20.0	7.3	3.6	3.71	.9559
3	I would like to become a Chemist when I complete secondary school education	3.6	18.2	12.7	56.4	9.1	2.51	1.016
4	Chemists do not have leisure time to spend with their families	1.8	12.7	25.5	45.5	14.5	2.419	.9563
5	It is wise to spend money buying chemistry materials and resources	16.4	50.9	20.0	9.1	3.6	3.673	.9823
6	It would be boring to work as a chemist	3.6	16.4	12.7	58.2	9.1	2.473	.9973
7	People who study chemistry look like any other people	5.5	7.3	14.5	45.5	27.3	2.182	1.090
8	Chemists make harmful discoveries	21.8	50.9	18.2	5.5	3.6	3.818	.9640
9	Working in a chemistry laboratory would be interesting	5.5	16.4	12.7	56.4	9.1	2.527	1.052
10	Studying chemistry makes you unfriendly to other people	1.8	14.5	23.6	45.5	14.5	2.436	.9768
11	Chemistry knowledge makes life better	20.0	45.5	21.8	12.7	0.0	3.727	.9320
12	A career prospect in chemistry would be boring	3.6	20.0	12.7	52.7	10.9	2.527	1.052
13	People who study chemistry can be athletic like other people	3.6	7.3	14.5	43.6	30.9	2.091	1.041
14	There are other secondary school subjects which are more important than chemistry	25.5	45.5	16.4	9.1	3.6	3.800	1.044
15	I would like to become a teacher of chemistry	1.8	16.4	12.7	52.7	16.4	2.346	1.004
16	People who study chemistry do so only to earn a living	0.0	16.4	23.6	47.3	12.7	2.436	.9182
17	Chemistry helps in making our planet a better place to live in	16.4	45.5	18.2	18.2	1.8	3.564	1.032
18	I wouldn't become a Chemist because it is a difficult field	1.8	20.0	12.7	54.5	10.9	2.473	.9973
19	People who study chemistry are as fit and healthy as others	3.6	9.1	14.5	49.1	23.6	2.200	1.026
20	Money spent on chemistry materials and chemicals is just wasted	18.2	45.5	21.8	10.9	3.6	3.636	1.025
21	It would be interesting to work as a chemist	0.0	16.4	10.9	56.4	16.4	2.273	.9320
22	Chemists are untidy	1.8	18.2	23.6	43.6	12.7	2.527	.9973
23	Chemistry is one of the most interesting subjects in school	16.4	50.9	20.0	9.1	3.6	3.673	.9823
24	I wouldn't like to work in a chemistry laboratory after completing school	3.6	16.4	10.9	63.6	5.5	2.491	.9598
	Average	8.2	26.0	17.0	37.2	11.5	2.821	.4592

The results of the study established that respondents in both groups had varied attitudes towards questionnaire items, and that the two groups Attitude Means of 2.81 for control and 2.82 for experimental groups showed that the two groups were equivalent in terms of attitude towards chemistry before ethnochemistry practices were integrated into chemistry lessons for the experimental group.

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3.2.0 Mean Attitude of transformed Likert Scores – Pretest

After each questionnaire item was analysed, the pre-test raw data was manipulated into a form that could be used to conduct analysis and to test the hypothesis. The rationale and procedure for manipulating questionnaire Likert scale score into a form to use to conduct analysis, and to test the hypothesis is well elaborated in SPSS Survival Manual by Pallant (2005: 78 – 89). For instance, the data for this research was normally distributed. Before performing statistical analyses on the questionnaire data, total attitude scores for each subject were calculated. This involved reversing all negatively worded items. The wording of twelve (12) items of the questionnaire was reversed in order to help prevent response bias. The step by step SPSS procedure for reversing the Likert scale scores has also been well outlined by Pallant (2005: 79-80). Manipulation of questionnaire Likert scale responses involved adding up the transformed scores from the 24 items that made up the Chemistry Related Attitude Questionnaire. This gave an overall attitude score. Since there were 24 items measured on a five (5) point Likert scale, the minimum total attitude score was 24, and the maximum was 120. Since there were 24 questionnaire items,the total attitude score for each respondent was divided by 24, in order to get the average attitude towards chemistry score for each respondent. All this was done within SPSS. The following are the charts showing the pre-test average Chemistry attitude scores:

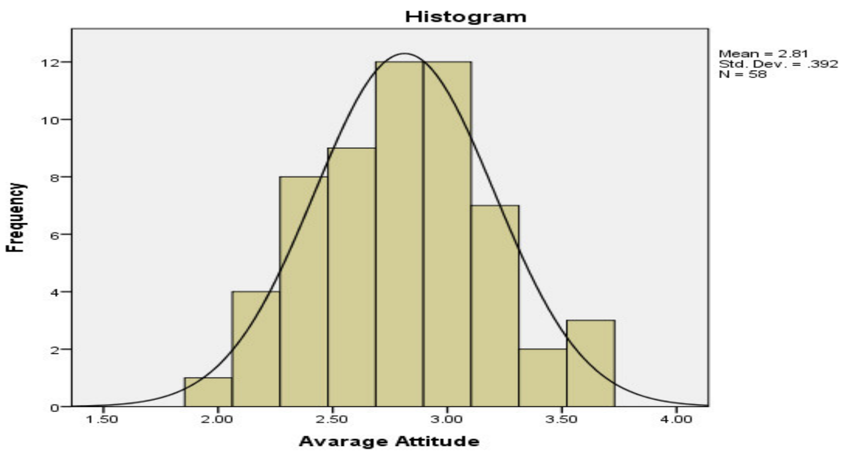

Chart 1: Control Group pre-test Average Attitude Scores

From the histogram in the Chart 1 above, it can be seen that the average attitudes for each respondent in the control group prior to treatment ranged from 1.75 to 3.75. In other words, it ranged from disagree, which was a negative attitude to Agree, a positive attitude towards chemistry. The respondents Mean chemistry related attitude was 2.8 (rounded off to 3), that is, neither agree nor disagree or a neutral opinion. This meant that most of the students in the control group were undecided as to their attitude towards chemistry.

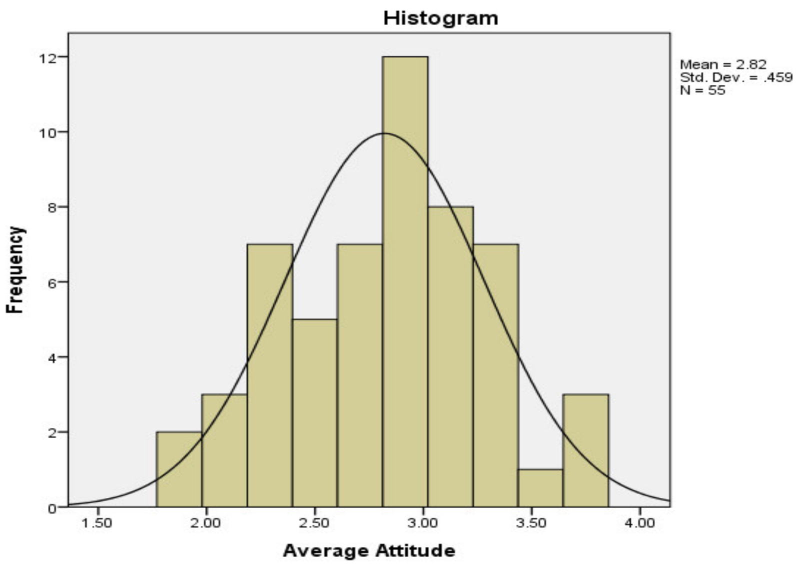

Chart 2: Experimental Group pretest Average Attitude Scores

From the histogram in chart 2 above it was observed that the average attitudes for each respondent in the experimental group prior to treatment ranged from 1.75 to 3.8. In other words, it ranged from disagree, which was a negative attitude to Agree, a positive attitude towards chemistry. The respondents Mean chemistry related attitude was 2.82 (rounded off to 3), that is, neither agree nor disagree or a neutral opinion. The Attitude Mean of 2.81 for the control group, and that of 2.82 for the experimental group, is indicative of the fact that the two groups were equivalent in terms of attitude towards Chemistry prior to the administration of the treatment.

The transformed total attitude scores for each respondent were used to conduct an independent samples t-test in order to ascertain the equivalence between groups prior to treatment. The following was the group statistics and independent t-test tables generated from SPSS for the pre-test.

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
TAttitude	control group pretest	58	67.52	9.409	1.236
	experimental group pretest	55	67.69	11.020	1.486

In the Group Statistics box, the mean for the control group chemistry related attitude was 67.52. The mean for the experimental group was 67.69. The standard deviation for the control group was 9.409, whereas that for the experimental group was 11.02. The number of participants in the control group was 58 whereas in the experimental group, they were 55. The experimental group performance mean (67.69) indicated that this group did not perform any better than the control group (Mean = 67.52).

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
TAttitude	Equal variances assumed	1.270	.262	-.090	111	.928	-.174	1.924	-3.987	3.640
	Equal variances not assumed			-.090	106.329	.929	-.174	1.932	-4.005	3.658

An independent-samples t-test was conducted to compare pre-test attitude towards Chemistry for control and experimental groups to ensure that the two groups were equivalent before administration of the treatment to the experimental group. There was no significant difference in the pre-test scores for control (M=67.52, SD=9.409) and experimental (M=67.69, SD=11.020) groups; t (111)= -0.090, p = 0.928. These results suggest that the control and experimental groups were equivalent in terms of attitude towards chemistry before treatment was administered.

3.3.0 Post-test Attitude Towards Chemistry Results

The chemistry attitude questionnaire was administered after treatment in order to assess whether integrating ethnochemistry knowledge in chemistry lessons had any effect on students' attitude towards chemistry. Firstly, analysis of questionnaire raw scores was done and then of transformed scores, and summed scores for control and experimental groups. Secondly, the results for the post-test to find out if there was any significant difference in attitude towards chemistry between the two groups was presented.

3.3.1 Post-test Attitude towards chemistry Results

The post-test questionnaire responses were analysed and outcome summarized in the following tables showing the post-test raw scores, chemistry attitudes for control group and then experimental group. The attitude mean and standard deviation were calculated from transformed scores in order to show the relative attitude mean on the five point Likert scale.

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Table 3: Post-test Control Group Chemistry Attitude Responses

	STATEMENT	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE	ATTITUDE MEAN	STD DEVIATION
		PERCENTAGE (%)						
1	Students who learn chemistry can behave normally	6.9	48.3	10.3	20.7	13.8	3.14	1.235
2	Chemistry has done more harm than good to humans	17.2	53.4	19.0	6.9	3.4	3.74	.947
3	I would like to become a Chemist when I complete secondary school education	3.4	17.2	12.1	58.6	8.6	2.48	.995
4	Chemists do not have leisure time to spend with their families	6.9	48.3	10.3	20.7	13.8	3.14	1.235
5	It is wise to spend money buying chemistry materials and resources	17.2	51.7	19.0	8.6	3.4	3.71	.973
6	It would be boring to work as a chemist	3.4	15.5	12.1	60.3	8.6	2.45	.976
7	People who study chemistry look like any other people	10.3	44.8	10.3	22.4	12.1	3.19	1.249
8	Chemists make harmful discoveries	22.4	50.0	19.0	5.2	3.4	3.83	.958
9	Working in a chemistry laboratory would be interesting	5.2	15.5	12.1	58.6	8.6	2.50	1.030
10	Studying chemistry makes you unfriendly to other people	6.9	44.8	13.8	13.8	20.7	3.03	1.311
11	Chemistry knowledge makes life better	20.7	46.6	20.7	12.1	0.0	3.76	.924
12	A career prospect in chemistry would be boring	3.4	20.7	12.1	53.4	10.3	2.53	1.047
13	People who study chemistry can be athletic like other people	19.0	37.9	17.2	12.1	13.8	3.36	1.307
14	There are other secondary school subjects which are more important than chemistry	25.9	46.6	15.5	8.6	3.4	3.83	1.028
15	I would like to become a teacher of chemistry	1.7	15.5	12.1	53.4	17.2	2.31	.995
16	People who study chemistry do so only to earn a living	6.9	46.6	12.1	19.0	15.5	3.10	1.252
17	Chemistry helps in making our planet a better place to live in	19.0	44.8	17.2	17.2	1.7	3.62	1.040
18	I wouldn't become a Chemist because it is a difficult field	1.7	19.0	12.1	56.9	10.3	2.45	.976
19	People who study chemistry are as fit and healthy as others	17.2	41.4	12.1	15.5	13.8	3.33	1.316
20	Money spent on chemistry materials and chemicals is just wasted	19.0	46.6	20.7	10.3	3.4	3.67	1.015
21	It would be interesting to work as a chemist	0.0	15.5	10.3	58.6	15.5	2.26	.909
22	Chemists are untidy	6.9	48.3	10.3	17.2	17.2	3.10	1.280
23	Chemistry is one of the most interesting subjects in school	17.2	51.7	19.0	8.6	3.4	3.71	.973
24	I wouldn't like to work in a chemistry laboratory after completing school	3.4	15.5	10.3	65.5	5.2	2.47	.941
	Average	10.9	36.9	14.2	28.5	9.5	3.12	.5792

The following table 4 presented the post-test chemistry related attitude questionnaire responses for experimental group.

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Table 4: Post-test Experimental Group Chemistry Attitudes Questionnaire Responses

	STATEMENT	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE	ATTITUDE MEAN	STD DEVIATION
		PERCENTAGE (%)						
1	Students who learn chemistry can behave normally	7.3	45.5	9.1	25.5	12.7	3.09	1.236
2	Chemistry has done more harm than good to humans	16.4	52.7	20.0	7.3	3.6	3.71	.956
3	I would like to become a Chemist when I complete secondary school education	14.5	47.3	12.7	25.5	0.0	3.51	1.034
4	Chemists do not have leisure time to spend with their families	9.1	45.5	9.1	23.6	12.7	3.15	1.253
5	It is wise to spend money buying chemistry materials and resources	16.4	50.9	20.0	9.1	3.6	3.67	.982
6	It would be boring to work as a chemist	14.5	47.3	12.7	25.5	0.0	3.51	1.034
7	People who study chemistry look like any other people	9.1	45.5	10.9	23.6	10.9	3.18	1.219
8	Chemists make harmful discoveries	21.8	50.9	18.2	5.5	3.6	3.82	.964
9	Working in a chemistry laboratory would be interesting	16.4	50.9	14.5	18.2	0.0	3.65	.966
10	Studying chemistry makes you unfriendly to other people	12.7	40.0	9.1	25.5	12.7	3.15	1.297
11	Chemistry knowledge makes life better	20.0	45.5	21.8	12.7	0.0	3.73	.932
12	A career prospect in chemistry would be boring	14.5	47.3	12.7	25.5	0.0	3.51	1.034
13	People who study chemistry can be athletic like other people	9.1	49.1	9.1	25.5	7.3	3.27	1.162
14	There are other secondary school subjects which are more important than chemistry	25.5	45.5	16.4	9.1	3.6	3.80	1.043
15	I would like to become a teacher of chemistry	14.5	49.1	14.5	21.8	0.0	3.56	.996
16	People who study chemistry do so only to earn a living	9.1	45.5	9.1	23.6	12.7	3.15	1.253
17	Chemistry helps in making our planet a better place to live in	16.4	45.5	18.2	18.2	1.8	3.56	1.032
18	I wouldn't become a Chemist because it is a difficult field	14.5	47.3	12.7	25.5	0.0	3.51	1.034
19	People who study chemistry are as fit and healthy as others	10.9	43.6	5.5	27.3	12.7	3.13	1.292
20	Money spent on chemistry materials and chemicals is just wasted	18.2	45.5	21.8	10.9	3.6	3.64	1.025
21	It would be interesting to work as a chemist	16.4	49.1	12.7	21.8	0.0	3.60	1.011
22	Chemists are untidy	10.9	47.3	5.5	27.3	9.1	3.24	1.232
23	Chemistry is one of the most interesting subjects in school	16.4	50.9	20.0	9.1	3.6	3.67	.982
24	I wouldn't like to work in a chemistry laboratory after completing school	20.0	43.6	9.1	27.3	0.0	3.56	1.102
	Average	14.8	47.2	13.6	19.8	4.8	3.50	.6116

The questionnaire responses presented in table 3 and 4 shows that both control and experimental groups had varied attitudes towards specific chemistry related attitude items even after treatment.

3.4.1 Mean Attitude of transformed Likert Scores – Post-test

After each questionnaire item was analysed, the post-test raw data was transformed and manipulated into a form that was used to conduct analysis as already outline in 3.2.0 above(Pallant, 2005). All this was done within SPSS.

The following charts show the post-test average Chemistry attitude scores:

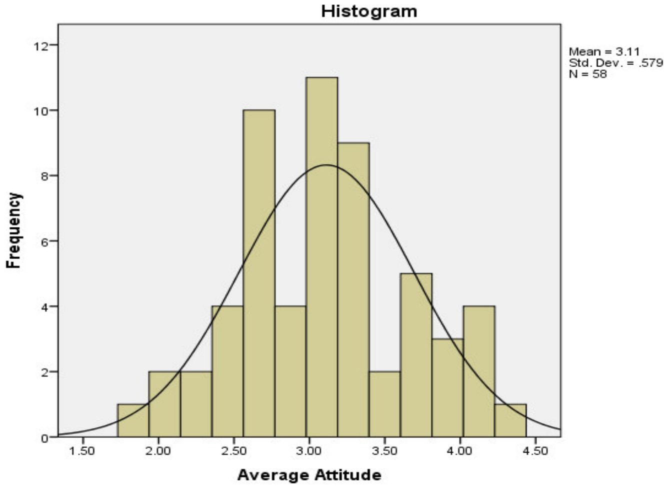

Chart 3: Control Group post-test Average Attitude Scores

From the histogram in chart3above, it can be seen that the average attitude scores for each respondent in the control group after treatment ranged from 1.75 to 4.4. In other words, it ranged from disagree, which was a negative attitude to Agree, a positive attitude towards chemistry. The respondents Mean chemistry related attitude was 3.11, that is, neither agree nor disagree or a neutral opinion. This meant that most of the students in the control group were undecided as to their attitude towards chemistry. However, there was a slight improvement in terms of attitude from the pre-test control group mean of 2.81 to that of 3.11 during the post test.

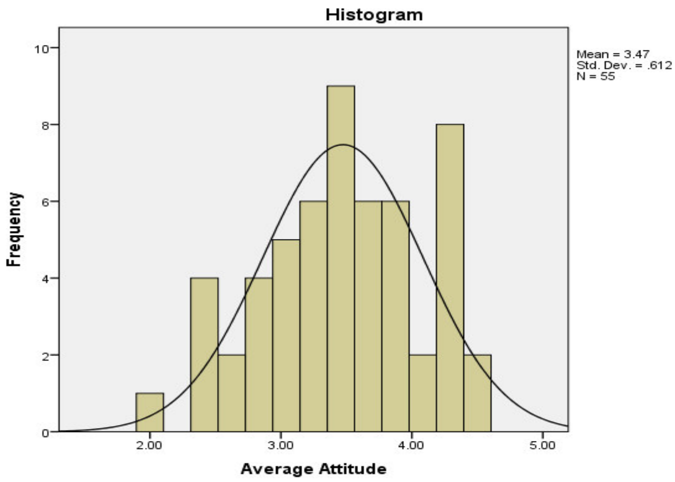

Chart 4: Experimental Group post-test Average Attitude Scores

From the histogram in chart 4 above it can be seen that the average attitude for each respondent in the experimental group after treatment ranged from 2.0 to 4.6. In other words, it ranged from disagree, which was a negative attitude to strongly agree, a positive attitude towards chemistry. The respondents Mean chemistry related attitude was 3.5 (rounded off to 4), that is agree. This meant that most of the students in the experimental group had positive attitude towards chemistry. The Attitude Mean of 3 for the control group, and that of 3.5 for the experimental group, is indicative of the fact that there was significant difference between the control and experimental groups in terms of attitude towards Chemistry after the administration of the treatment.

The foregoing analyses have established that respondents in both groups had varied attitudes towards questionnaire items, and that the two groups Attitude Means of 3 for control and 3.5 for experimental groups show that these two groups were significantly differentin terms of attitude towards chemistry after ethnochemistry practices were integrated in chemistry lessons for the experimental group. In order to ascertain if there was a statistically significant difference between the control and experimental groups on attitude towards chemistry after treatment, an independent samples t-test was conducted.

The Likert scores were transformed and total attitude scores for each respondent were used following the same procedure stipulated in 3.2.0 (Pallant, 2005). Manipulation of questionnaire Likert scale responses involved adding up the transformed scores from the 24 items that made up the Chemistry Related Attitude Questionnaire. This gave an overall attitude towards chemistry score. Since there were 24 items measured on a five (5) point Likert scale, the minimum total attitude score was 24, and the maximum was 120. Further, since Likert scores are ordinal, it was assumed that they were interval scores in order to test the hypothesis. The following are the group statistics and independent t-test tables generated from SPSS.

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Attitude	Control Group Posttest Attitude	58	74.71	13.901	1.825
	Experimental Group Posttest Attitude	55	83.36	14.677	1.979

In the Group Statistics table, the Mean for the control group post-test chemistry related attitudes is 74.71. The mean for the experimental group is 83.36. The standard deviation for the control group is 13.90 whereas that for the experimental group is 14.68. The number of participants in the control group is 58 whereas in the experimental group, they were 55. The experimental group attitude mean (83.36) indicates that this group had far better positive attitude than the control group (Mean = 74.71).

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Attitude	Equal variances assumed	.213	.645	-3.220	111	.002	-8.657	2.688	-13.984	-3.330
	Equal variances not assumed			-3.215	109.725	.002	-8.657	2.692	-13.992	-3.321

Effect Size

According to Pallant (2005: 208) effect size statistics provide an indication of the magnitude of the differences between the control and experimental groups, and not just whether the difference could have occurred by chance. One way to obtain effect size is to manually calculate eta squared since SPSS does not provide eta squared values for t-tests. Eta squared represents the proportion of variance in the dependent variable that is explained by the independent variable.

Eta squared = $\frac{t^2}{t^2+(N1+N2-2)}$

Replacing the appropriate values from our post-test independent t-test output:

Eta squared = $\frac{-3.22^2}{-3.22^2+(58+55-2)}$

= 0.085

The guidelines proposed by Cohen (1988) for interpreting Eta squared values are: .01=small effect, .06=moderate effect, .14=large effect. For our post-test results we can see that the effect size is between moderate effect and large effect.

An independent-samples t-test was conducted to compare post-test chemistry related attitudes for control and experimental groups after administration of the treatment to the experimental group. There was a statistically significant difference in the post-test attitude scores for control (M=74.71, SD=13.90)and experimental (M=83.36, S=14.68)groups; t (111)= -3.22, p = 0.002. The magnitude of the differences in the means was moderate (eta squared =.085).

4.0.0 Discussion of Findings

4.1.1 Effect of ethnochemistry practices on students attitude towards chemistry

In this study, it has been found that incorporating ethnochemistry practices in teaching chemistry does have an effect on secondary school students' attitude towards chemistry. The results suggest that when ethnochemistry practices are incorporated in chemistry lessons, secondary school students' attitude towards chemistry is enhanced significantly and it generally becomes positive. Already there is evidence that ethnochemistry knowledge has been greate inspiration to students. Ssereo (2012) discovered chemistry during her childhood in Kenya. This motivated her to like chemistry when she was finally introduced to the subject when she went to High School.

4.2.0 Conclusions

The study has proven that incorporating ethnochemistry practices in teaching chemistry does have a significant effect in improving secondary school students' attitude towards chemistry. When ethnochemistry practices are incorporated in chemistry lessons, secondary school students' attitude towards chemistry is appreciably enhanced and it generally becomes positive. The improvement in attitudes shall profoundly help better understand the subject in depth.

4.3.0 Recommendations of the Study

Based on the findings of the study the following recommendations were made:

i) It is desirable that studies to document all the ethnochemistry practices be emphasized and encouraged.
ii) The integration of appropriate Ethnochemistry knowledge in chemistry lessons merits attention.
iii) The workshops and seminars may be organised to popularize and sensitize teachers of chemistry on the integration of ethnochemistry knowledge in teaching students chemistry concepts.
iv) Teacher training institutions of learning may include the integration of appropriate ethnochemistry knowledge in chemistry lessons. This will guarantee that after the teacher training, they will be equipped on how to teach certain chemistry concepts effectively.

4.4.0 Recommendations for Future Research

i) In this study, only a few ethnochemistry practices have been documented. Further research should be undertaken to document all the ethnochemistry practices that would help in enhancing secondary school students' attitude and performance in chemistry.
ii) Similar studies may be carried out in other sciences.

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Appendix: Scale Allocation and Scoring for Each Questionnaire Item

Item	Item	Item
1 (+)	2 (-)	3 (+)
4 (-)	5(+)	6 (-)
7 (+)	8 (-)	9 (+)
10 (-)	11(+)	12 (-)
13 (+)	14 (-)	15 (+)
16 (-)	17 (+)	18 (-)
19 (+)	20 (-)	21(+)
22 (-)	23 (+)	24 (-)

For Positive Statements the scores are: Strongly Agree = 5, Agree = 4, Neither Agree nor Disagree = 3, Disagree = 2, Strongly Disagree = 1

For Negative Statements the score are: Strongly Disagree = 5, Disagree = 4, Neither Agree nor Disagree = 3, Agree = 2, Strongly Agree = 1.