# INTEGRATING SOCIO-ECONOMIC ACTIVITIES OF THE LOCAL COMMUNITY INTO CHEMISTRY LESSONS: A CASE OF FERMENTATION AND INCOMPLETE COMBUSTION AT MALAMBANYAMA DAY SECONDARY SCHOOL IN CHIBOMBO DISTRICT IN CENTRAL PROVINCE OF ZAMBIA

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**ABSTRACT**

The purpose of this study was to investigate the impact of integrating socio-economic activities of the local community into chemistry lessons, on attitude and performance of learners. Mixed method research design was used to collect both quantitative and qualitative data. Quantitative data was gathered by CATs and the attitude questionnaire while focus group interviews were used to collect qualitative data. The only grade 12 class at Malambanyama Day Secondary school comprising 43 learners was purposively selected since learners were information-rich. The learners were randomly selected into groups 1 and 2, and the two groups were assigned to the control and treatment groups. The data collected were analyzed by the independent samples t-test, and the Qualitative Data Analysis software. Results obtained indicated that participants' attitude at pre-intervention was neutral and positive at post-intervention. Pre-test CAT indicated that the two groups were equal in conceptual understanding: (group 1 $M = 39.71$, $SD = 14.94$, group 2 $M = 39.12$, $SD = 11.35$), $t(32) = .129$, $P = .449$, $\alpha = .05$ at confidence level 95%. At posttest 1 CAT, results were statistically significant (group 1 $M = 65.79$, $SD = 14.94$ while group 2 $M = 54.58$, $SD = 11.35$), $P = .029$, $t(29) = 1.972$, $\alpha = .05$ at confidence level 95%. At posttest 2 CAT, results were not statistically significant: (group 1 $M = 50.91$, $SD = 16.52$, group 2 $M = 54.05$, $SD = 18.14$), $p = .278$, $t(41) = -.594$, $\alpha = .05$ at confidence level 95%. Qualitative data analysis results also indicated that learners' attitude towards chemistry improved when socio-economic activities of learners were incorporated in chemistry lessons. It was, therefore, concluded that integration of socio-economic activities of the local community into chemistry lessons improve both the attitude and academic performance of learner. *[African Journal of Chemical Education—AJCE 10(1), January 2020]*

## INTRODUCTION

Chemistry knowledge and its applications have made tremendous contributions towards socio-economic advancement of most countries in the world. Banda, Mudenda, Tindi and Nakai and [1] ECZ reports [2] state that national and international examinations results show that learners perform poorly in chemistry and science (physics and chemistry). Young [3] and Ugwu and Diovu [4] advice that educators must find the most suitable pedagogy that could be used to help learners learn chemistry with less difficulty. It is important that this failure is addressed so that professionals in the natural sciences fields may have the much needed knowledge and competences. If this is not addressed it may have negative impact on the employability of individuals and the well-being of humankind Tichapondwa [5].

### Causes of learning difficulties

Adesoji and Okpan (cited in Abonyi and Njoku [6] lament that African learners have become academic foreigners in their own land. They meant that the teaching methods and materials used in most African science lessons did not take into account the culture of learners. Omolewa [7] on the other hand argues that modern schools do not take into account the inherent ways through which an African child learns successfully. He cites examples of learning through native language, music and dance, local technological artifacts and skills, local specialists, elders, religion, integrating theory and practice and others.

Most schools in Africa and Zambia inclusive use non-African languages as 'academic languages' in the teaching-learning processes. According to Hewitt and Bradshaw [8] academic language is a language that students are required to use in order to learn in school. In Zambian, the academic language is English, and it is either a second or third language to most learners since the children are trained in Zambian languages at their homes. This means that English acquisition is only limited to the classroom. This compromises the proficiency of the learners in English, and it becomes difficult for learners to grasp the concepts in a foreign language. Hence, (Hewitt and Bradshaw [8] conclude that the use of English language in schools has the potential to affect the levels of learner success in schools. On the other hand, a learner is overloaded with work because they have to learn both the foreign language and the content simultaneously Wellington and Osborne [9]. This may be a source of confusion and failure among the learners.

Omolewa [7] argues that most African cultural-artifacts and skills are not used as examples for learning in most African science lessons. Instead, European artifacts and skills are used as teaching aids. These, like language, are strange to learners, and this makes the learning of chemistry difficult. Omolewa [7] further contends that most modern teachers do not use methods that promote commitment of learning material to long-term memory, hence, learners do not learn for service to their society. Instead they learn chemistry for the sake of passing the national examinations, getting certification and recognition in society (Tichapondwa [5] and Nashon and Anderson [10]. This limits learners' understanding of the subject because the motive of learning is not for knowledge acquisition. Some teachers do not see the need to contextualize their chemistry lessons using indigenous knowledge because researchers from the Western community do not accept the existence of indigenous science. They look down upon it and exclude it from classroom science because they believe it is not a science at all (Shumba [11] and Sinevely and Corsglia [12].

**Suggestions to improve learner performance in Chemistry**

It is clear from the foregoing that most of the difficulties emanate from the failure by educators to select and use contexts and teaching methods that are familiar to learners. This is probably the reason why Ausubel [13] says that 'the most important single factor influencing learning is what the learner already knows'. In line with Ausubel's [13] assertion, some proponents have suggested the following as some of the ways that could be used by educators to minimize the learning difficulties in chemistry.

The first suggestion is through use of contextualization. Giamellaro [14] defines contextualization as 'a process of drawing specific connections between content knowledge with the context in which the content can be relevantly applied'. Wyatt [15] defines context as familiar knowledge which learners come with to school from their society while content knowledge is curricular knowledge which is taught in schools. Omolewa [7], Abonyi and Njoku [6] and Ugwu and Diovu [4] contend that contextualizing lessons improves attitude, interest, engagement and performance of learners in chemistry. It also brings out sense of ownership of chemistry applications, and this may also reduce its abstractness. When educators use contexts that are familiar, learners are able to link the content to context, and learners are able to create meaning and learners are able to see the value of the subject in their lives.

Omolewa [7] educates further that an African child learns better through specialists. Traditional African learner learns better through specialists such as traditional medical practitioners, surgical workers, wood workers, gold and ironsmith, and many others. These specialists made sure that their apprentices get the necessary knowledge and skills in their specializations by working hard. They worked not only for their economic gain but also for service and survival of their communities. In the same vein, learners of today must not only learn from teachers in class, they must be taken out of class for specialized learning in different fields according to their curriculum. Specialists may explain the concepts better than some teachers. They would also serve as role models who could be sources of motivation for learners. Learners must understand that they do not learn only for employment, but also for productivity and survival of their society.

Omolewa [7] argues that Africans education combines academic learning with workplace applications by focusing on concrete life skills and knowledge. For example, medicinal plant identification, performance of a traditional song, performance of a dance, preparation of a local dish. This kind of learning is good because it promotes hands-on activities and the utility value of knowledge and skills to the learners. When learners realize the applicability of the skill and its importance, they begin to value education. They may develop higher interest levels, begin to enjoy the subject, spend more time reading, and expend more energy on learning the subject. This eventually results in better conceptual understanding and improved academic performance.

The second way is through use of ethnoscience in chemistry lessons. Abonyi and Njoku [6] define ethnoscience as ‘knowledge which is inherent to a particular language and culture which deals with local perception, practices, skills and ideas in the context of socio-economic and sustainable development’. There is evidence that learners learn better in their socio-cultural context (Gerdes [16], Omolewa [7] and Young [17]. Hence, Sefa [18] urges educators to use examples and methodologies rooted in learners’ local culture in chemistry lessons. Africans had strong knowledge structures in all activities of their societies, such as in food production and preservation, medicinal herbs, engineering, animal husbandry, mathematics, navigation, ecology, crop management, tool making, metal extraction, experimentations in edible and inedible plants, and nomenclature (Sinevely and Corsiglia [12], Omolewa [7] and Abonyi and Njoku [6]).

Just to elaborate more on nomenclature, among the Tonga speaking people of southern province of Zambia, the naming of children is quite systematic. As examples, let us consider the names: Hang'ombe, Hababwa, Hamilonga, Habasimbi and Hankuku. These are usually ancestral names that exhibit the characteristics of their fore fathers. 'Ha' in all the above names serves as an adjective or prefix which may be analogous to the prefix 'alk' in the organic chemistry families, such as alkanes, alkenes, alkynes, alkanols and alkanoics. In order to understand the family where a named organic compound belongs to, one has to consider the suffixes 'ane', 'ene', 'nol', noic'. In a similar manner, in order to get the meaning of these names, one has to understand the meaning of the suffixes 'ng'ombe', 'nkuku', 'babwa', 'milonga', and 'basimbi'.

In other words, the adjective 'Ha' adds meaning to a noun or suffix. For example, the name 'Habanyama' means a person likes banyama (animals). Similarly, 'Hamilonga' means somebody who likes staying near rivers and all activities that are synonymous with rivers such as fishing. Habasimbi may mean a man or boy who likes playing with girls or women. It might also mean a man or boy who is very promiscuous. This knowledge exhibited by the Africans shows that they actually had systematic reasoning.

From the forgoing, it is clear that they can be used as examples in the teaching and learning of chemistry. Integration ethnoscience with modern science is not only important for ease construction of knowledge by learners, but it is also important in order to localize the curriculum. A curriculum which students cannot identify themselves with creates an artificial distance, alienation and they become resistant to its content. Integration makes the learning experiences meaningful, relevant, interesting, and engaging to the learners.

The third suggestion to improve learner performance in chemistry is through use of constructivist approach. Constructivism is a learner centered approach where learners are able to construct their knowledge by analyzing, synthesizing, comparing and evaluating the new information in the light of old information. Hence, it can be argued that ethnoscience and contextualization can be good sources of knowledge construction by learners since both can serve as pre-requisite knowledge of learners. Some scholars argue that constructivism is the best learning philosophy because its learning is meaningful (Bruner [19], Canas and Novak [20]). They argue that it is meaningful because it has the potential to produce minds that are able to think creatively and critically, make decisions, solve problems collaboratively, and communicate proficiently (Educating our future [21], Cirik, Colak and Kaya [22]).

## PURPOSE OF THE STUDY

In Zambia, among the natural science subjects (Mathematics, Science and Biology), science has been persistently recording larger numbers of failures (Namayanga and Sato [23], Banda, Mudenda, Tindi and Nakai [1] and ECZ [2]). Some of the factors that lead to the failure of learners are poor teaching methods used by some teachers. For example, some teachers portray chemistry as an alien subject by using foreign contexts (Ugwu and Diovu [4]). Dzama and Osborne (cited in Mahajan and Singh [24]) state that lack of relevance of the material being learnt by learners in terms economic gain lead to failure of some learners.

By integrating scientific-socio-economic activities of the local community into chemistry lessons, it was hoped that learners would realise the economic importance of chemistry in their society. Once this was borne in learners' minds, it was assumed that the abstractness of chemistry would be reduced and, hence, improve the attitudes, and probably the achievement of learners in the subject. It was also thought that the study would somehow inform learners that chemistry was not as alien as they first thought since it was practiced in their communities. It was also thought that the use of local resources and wisdom in manufacturing tangible products (charcoal and Kachasu) would further signal the presence and ownership of indigenous science around Malambanyama community. This would develop self-belief in the learners since they would realize that scientific concepts were practiced daily in their community. This research would as well enrich the pedagogical knowledge of chemistry teachers. It would also be helpful to the curriculum developers and teacher training institutions by encouraging teachers to apply socio-economic activities in their pedagogical skills in order to make the learning of chemistry more meaningful.

From the foregoing, methodological, scope and conceptual gaps were identified by the current research, and hence, it was felt that the research had to be re-done in the following ways:

1. Mixed method research design was used where quantitative and qualitative data was collected and analysed.
2. The current study carried out the study with learners coming from the community where the cultural practices of alcohol brewing and charcoal burning actually take place.
3. The learners were immersed in authentic cultural-learning-environments where they interacted with the brewers and charcoal burners, and asked questions for the purpose of learning.
4. While previous researchers emphasized on the importance of indigenous knowledge and its practices in the teaching-learning of chemistry, the current study adds the concept of economic value of chemistry knowledge and its applications. This made learners realize that chemistry is important for economic development of a family, community, nation and the world at large.

## METHODOLOGY

Prior to beginning of the study, the researcher visited the 'factory owners' to investigate the chemistry applications involved in their Socio-Economic Activities (SEA). The specialists (brewer and charcoal burners) were interviewed on the processes involved in manufacturing their products. Later, arrangements for learners' visitations were made. At the beginning of the study, pre-intervention attitude questionnaire was administered to the whole class to find out the general attitude of learners towards chemistry.

Thereafter, the learners were randomly selected and assigned to groups 1 and 2. Then, both groups were taught 'fermentation' by the researcher at the same time using Lecture Discussion Method (LDM). The day that followed, group 1 was treated with SEA by visiting the Kachasu-brewer's factory for interaction with the brewer while group 2 members remained studying in class. Learners were able to ask the brewer some questions with reference to the focus questions prepared in advance by the researcher. However, learners were allowed to ask questions of their own interest.

The Kachasu-brewer started by showing the learners how she does her mixtures of the raw materials. Learners could ask the brewer why she did what she was doing at each step for clarity. The brewer gave explanations and learners were writing in their note books. The researcher could also give further explanations to consolidate learner understanding. Group interviews were conducted immediately after the lesson session at the same venue while events were still fresh in participants' minds. The interview was recorded using a mobile phone by a villager who was trained to capture the transactions during the interviews.

In order to deal with participants' unnatural reaction due to the presence of a camera at the research sites, the researcher had started using the camera in ordinary classes as a way of familiarizing them with it prior to the actual study (Tichapondwa [5]). Two weeks later, posttest 1 was administered to both groups at the same time. Transcripts were marked and marks were recorded. Later, a new topic, 'incomplete' combustion of wood was taught to the whole class using LDM at the same time by the same researcher. On the day that followed, group 2 visited the charcoal burner's factory for the learning purpose while group 1 remained studying in class. Figure 1 depicts the setup of the counter-balanced groups at experimental stage.

**Phase I**

| | | | | |
|---|---|---|---|---|
| R | $O_1$ | X | $O_2$ | Intervention group |
| R | $O_3$ | | $O_4$ | Control group |

**Phase II**

| | | | | |
|---|---|---|---|---|
| R | $O_1$ | | $O_2$ | Control group |
| R | $O_3$ | X | $O_4$ | Intervention group |

Figure 1: Depiction of counter-balanced groups at experimental stage

Notes.

O = observation/measurement

X = treatment or intervention given

This was done in order to make all the participants to benefit in the study (Creswell [25]). Whilst there, learners asked the charcoal burner questions using the focus questions that were prepared earlier by the researcher, though they were also free to ask their own questions. Participants were taking note of the responses given by the charcoal burner in their notebooks.

This group was also interviewed to establish their views on integration of SEA in chemistry lessons. Group interviews were equally conducted. Two weeks later, posttest 2 was administered to both groups at the same time in the same room, transcripts were marked and results recorded. Finally the same questionnaire was re-administered to all the learners to establish what their attitude was at the end of the study.

**Research setting**

The study was carried out at Malambanyama Day Secondary School in Chibombo District in Central Province of Zambia. The main economic activities of the local people are mixed agriculture where they grow crops and keep herds of cattle. Due to economic hardships, some farmers have also engaged in charcoal burning while others brew traditional beer, locally known as Kachasu. Through these socio-economic activities, parents are able to raise money to send their children to school, buy farming inputs, and for livelihood. The target population were all grade 12 learners in Chibombo district.

**Target population and sampling techniques**

Grade 12 learners were purposively selected for this study for many reasons. They were not only information-rich, but they were also more involved in helping the parents doing the work at home than the younger learners. Apart from that, the topics (fermentation and incomplete combustion) are learnt in grade 12 in Zambia. The grade 12 class had a total of 43 learners, out of which 26 (60.5%) were boys while 17 (39.5%) were girls.

**Research Instruments**

Attitude questionnaire, chemistry assessment tests (CATs) and focus group interviews were used to gather data. The attitude questionnaire items were adapted from Salta and Tzougraki [26] and Cheung [27]. The interview items were adapted from Nashon and Anderson [10]. CATs were developed by the researcher. Pilot testing was done with a grade 11 class since the school had only one grade 12 class which was reserved for the actual study. Pilot testing involved LDM and SEA at the Kachasu and Charcoal production sites. Pre-test, post-tests, questionnaire and interviews items were administered to the pilot class. Pilot testing took four weeks before commencement of the actual research. Necessary amendments were done to the test items, questionnaire items and methodology in order to fine-tune the instruments.

**Validity of Instruments**

Validity refers to the extent to which research instruments and methodologies measure the variables (Creswell [25] and Tichapondwa [5]). In order to be sure that the observed results in the response variable were caused by the treatment and not some confounding variables, the following conditions were put in place. Firstly, the participants were randomly selected and assigned to group 1 and 2 in order to eliminate personal bias in the study. Secondly, learners in the two groups were taught the same material by the same teacher at the same time. Thirdly, treatment (SEA) was given to one group at a time to find out its effect on the mean scores for each group at post 1 and 2. Since both groups 1 and 2 benefited from the treatment, this compensated for resentment by any group. Fourthly, the instruments were validated by peers and the promoter of the study. Also, the CATs used at pre-test and post-test 1 and 2 had different items while the content was maintained in order to prevent learners from remembering the responses from previous tests. For example, at pre-test the CAT assessed the chemistry applications involved in both fermentation and incomplete combustion while at post-test 1 and 2, the CATs assessed chemistry applications involved in Kachasu production and charcoal burning respectively.

**Reliability**

Salta and Tzougraki [26] established the reliability of the items as 0.89, using Cronbach alpha. They were scrutinized for reliability and those which seemed not to measure the constructs were deleted with advice from peers and the supervisor. The rationale was that all items on the questionnaire must measure the same constructs as much as possible. The variable ‘attitude’ has three word-subsets embedded in it, namely thinking, emotions and actions (Salta and Tzougraki [26]) while Cheung [27] added the fourth one, ‘evaluative belief’. These were the dimensions considered when adapting the questionnaire items. The questionnaire consisted of three questions on thinking, three questions on actions, four questions on feelings and four questions on beliefs of learners. Reliability of CATs was achieved by administering CATs on days which were free from peculiar events in the school, such as sports (Salkind [28]).

**Test for Normality of Sample Score Distribution**

Pallant [29] proposes various methods that could be used to test for normality of the sample score distribution such as the Kolmogorov-Smirnov/Shapiro table, histograms, boxplots, percentile-percentile plots, among others. Keya and Rahmatulah [30] advise that normality must be assessed both analytically and graphically. The Kolmogorov-Smirnov/Shapiro data in Table 1 gives direct and objective information on normality of data while graphical data provides an opportunity for the audience to either confirm or disconfirm the status claimed by the table (Keya and Rahmatulah [30]). Shapiro-Wilk, Table 1, was used to test for normality of data against the alpha level (0.05) because it was proved to be more sensitive to samples having 50 or less cases, than the Kolmogorov-Smirnov.

It was observed that all the significant values under the Shapiro-Wilk section on table 6 were greater than 0.05, except for .048 for post-test 2.048 clearly shows that data for group 2 alone was not normal while the rest were normal. However, the independent samples t-test was still used for analysis of data because Pallant [29] advises that parametric tests could still be used for data analysis despite part of the data not being normally distributed because they are robust. This means that they can tolerate minor violations of the assumptions without causing major problems. Keya and Rahmatulah [30] also caution that non-normal sample distributions are more frequently met in studies than normal ones.

Table 1: Results for tests for normality of sample score distribution

| | Group | Kolmogorov-Smirnov | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|---|
| | | Statistic | Df | Sig. | Statistic | df | Sig. |
| Pretest | Group 1 | 0.109 | 17 | 0.200* | 0.951 | 17 | 0.471 |
| | Group 2 | 0.185 | 17 | 0.127 | 0.931 | 17 | 0.226 |
| Posttest1 | Group 1 | 0.131 | 19 | 0.200 | 0.931 | 19 | 0.181 |
| | Group 2 | 0.261 | 12 | 0.023 | 0.889 | 12 | 0.115 |
| Posttest2 | Group 1 | 0.129 | 22 | 0.200 | 0.979 | 22 | 0.899 |
| | Group 2 | 0.215 | 21 | 0.012 | .907 | 21 | 0.048 |

## RESULTS AND FINDINGS

### A. Pre and post-intervention attitude responses

The fourteen questionnaire items were analysed by the SPSS software to find out whether there was learner attitude change between the pre and post-intervention. The results showed that participants' attitude changed from negative at pre-intervention to positive at post-intervention, Table 2. This was indicated by a larger number of participants responding positively (agree and strongly agree responses) at post-intervention than at pre-intervention. For example, the number of respondents who responded positively to the statement 'chemistry is my favourite subject', at pre-intervention were 22, while at post-intervention were 41.

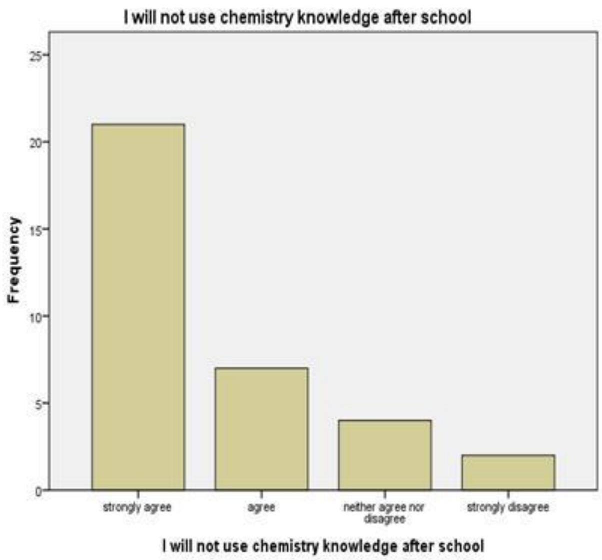
Data was further analyzed to establish the attitude mean score for all the 43 participants per questionnaire item. For example, the mean score for the statement, 'Chemistry is my favorite subject' at pre-intervention was 2.147 and at post-intervention was 1.791. Thus the attitude changed from 'agree' to 'strongly agree'. This trend was the same for the rest of the questionnaire items. The overall mean scores at pre and post intervention were also found. At pre-intervention, the overall mean score for all the 14 questionnaire items was 2.513. This was found by adding all the scores for the 43 participants for all the 14 questionnaire items, and dividing the sum by 14. The 2.513 was rounded-up to a whole number since the responses were whole numbers. When rounded-up, 2.513 became 3.000, this meant that at pre-intervention the overall attitude mean score for this questionnaire was neither agree nor disagree. In other words the learners' attitude was neutral. At post-intervention, the steps that were used to find the overall mean score for the pre-intervention was repeated, and the mean score found was 2.000. This meant that the learners' attitude changed from neutral to agree.

Table 2: Comparison of pre and post-intervention attitude mean scores (N=43)

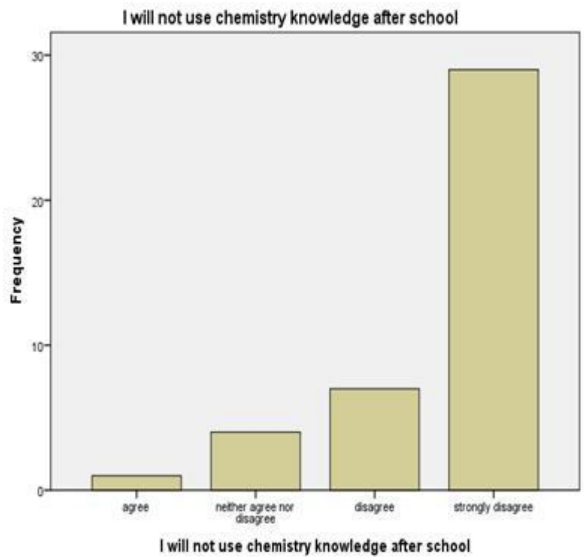
| S/No | Statement | Pre-intervention | | Post-intervention | | Effect on attitude |
|---|---|---|---|---|---|---|
| | | Mean score | response | Mean score | Response | |
| 1 | Chemistry is my favorite subject | 2.147 | Agree | 1.791 | Strongly agree | Positive |
| 2 | I spend more time reading chemistry books | 3.091 | Neutral | 2.070 | Agree | Positive |
| 3 | I solve chemistry exercises | 2.029 | Agree | 1.732 | Strongly agree | Positive |
| 4 | Feel sad when I miss chemistry lesson | 1.971 | Strongly agree | 1.721 | Strongly agree | Positive |
| 5 | I lose concentration in learning chemistry | 3.294 | Neutral | 3.561 | Neutral | positive |
| 6 | Not use chemistry knowledge after school | 1.677 | Strongly agree | 4.561 | disagree | Positive |
| 7 | Will study a course related to chemistry college or university | 2.559 | Agree | 2.535 | Agree | Positive |
| 8 | Cannot earn a living through chemistry knowledge | 2.147 | Agree | 2.861 | Agree | Positive |
| 9 | Our ancestors had knowledge of chemistry practices | 3.177 | Neutral | 2.238 | Agree | Positive |
| 10 | Knowledge of chemistry important in daily work | 2.647 | Agree | 1.550 | Strongly agree | Positive |
| 11 | Connect chemistry to daily activities in our society | 2.441 | Agree | 1.465 | Strongly agree | Positive |
| 12 | Societal activities to be used as examples in chemistry lessons | 2.088 | Agree | 1.881 | Strongly agree | Positive |
| 13 | Chemistry practiced in my village | 3.000 | Neutral | 1.651 | Strongly agree | Positive |
| 14 | Chemistry important for economic development | 2.912 | Agree | 1.535 | Strongly agree | Positive |
| | Overall mean score | 2.5 | Agree | 2.002 | Agree | |

The following bar graphs show atypical response to the question ‘I will not use chemistry knowledge after school during the pre- and post-test question, question from the above Table’. There was a clear interest in students to learn that chemistry occurs in their everyday life after being exposed to treatment by visiting the charcoal burning and fermentation sites in their communities.

PRETEST




POSTTEST




**B. Achievement mean scores**

At the beginning of the study learners from the same class were randomly selected and assigned into groups 1 and 2. The two groups were assessed at pre-test in order to establish their conceptual understanding. Thereafter, the whole class was taught fermentation using LDM. The day that followed, group 1 was exposed to SEA by taking the learners to the brewer's factory where they learnt more about fermentation while group 2 was denied the treatment. Two weeks later, assessment was given to both groups and results were recorded as post-test 1.

At phase II, the whole class was taught incomplete combustion of wood using LDM, and treatment was given to group 2 while group 1 was denied the treatment. Two weeks later an assessment was given to the whole class and results were recorded as post-test 2. Table 3 summaries the chemistry assessment results obtained at pre-test, post-test 1 and 2.

Table 3: A summary of chemistry achievement mean scores at pre-test and post-test 1 and 2

| Group | Pre-test Mean(SD) | Phase I | Post-test I Me(SD) | Phase II | Post-test II Mean(SD) |
|---|---|---|---|---|---|
| Group 1 | 39.71 (14.94) | LDM and SEA (Fermentation) | 65.79 (15.92) | LDM | 50.91 ( 16.52) |
| Group 2 | 39.12 (11.35) | LDM | 54.58 (14.53) | LDM and SEA (Incomplete combustion) | 54.05 (18.14) |

Note.
LDM = lecture discussion method only
LDM and SEA = Lecture discussion method and social economic activities
Adapted from Chisenga, Daka and Shumba [31]

**(i) Pre-test results for groups 1 and 2**

Group 1 (M = 39.71, SD = 14.94) while group 2 (M = 39.12, SD = 11.35). The performance mean difference, .59, was analyzed using the independent samples t-test to find out whether or not it was statistically significant. Results obtained indicated that Levene's test (.156) > .05, meaning the two groups had equal variations in scores. Results equally showed that there was no significant performance mean difference between the two groups; p = .449, t (32) = .129, α = .05 at confidence level 95%. The research failed to reject the null hypothesis since P > .05.

**(ii) Post-test 1 performance results for groups 1 and 2**

At phase I, the whole class was taught using LDM. The day that followed, treatment was given to group 1 alone where learners went to learn at the brewer's factory, while group 2 informants were denied the treatment. Two weeks after the treatment the whole class was assessed, and data obtained was analysed using the SPSS software. Group 1 had (M = 65.79, SD = 14.94) while group 2 had (M = 54.58, SD = 11.35). The performance mean difference between group 1 and 2 (11.21) was analyzed by the independent sample t-test to find out whether it was statistically different or not. Results from the Levene's test (.387) >.05, showed that the two groups had equal variation in scores, p = .029, t (29) = 1.972, α = .05 at confidence level 95%. P < .05, hence, rejected the null hypothesis, meaning that the difference between the two groups was statistically significant.

### (iii) Post-test 2 performance results for groups 1and 2

At phase II, the whole class was taught using LDM. Later on, group 2 participants were treated with the SEA by learning at the charcoal burner's factory while group 1 participants were denied the treatment. The whole class was later assessed, and data was statistically analysed using the SPSS software. At post-test 2 group 1 (M = 50.91, SD = 16.52 while group 2 M = 54.05, SD = 18.13). The performance mean score difference between the two groups (3.14) was analysed using the independent samples t-test in order to find out whether it was statistically significant or not. The SPSS output obtained in Table 14 showed that Levene's test (.377) > .05, meaning that the scores for the two groups had equal variance, p = .278, t (41) = -.594, α = .05 at confidence level 95%. P > .05, meaning that the difference was not significant, hence, failed to reject the null hypothesis.

## C. The Interview Results

The interviews were conducted at the economic sites immediately after the learning activities. This was promptly done because it was believed that learners would be enthusiastic in giving responses since events would still be fresh in their minds. The interview guide had both structured and open-ended questions. The structured questions created a base for probing the respondents further while the open-ended questions enabled them to provide detailed responses to the problem. This helped the researcher to understand the views, perceptions, opinions, feelings and beliefs of the informants about incorporation of SEA of the local community into the learning of chemistry (Tichapondwa [5]). Proceedings of the interview were recorded and later transcribed from audio to symbolic language. Due to the voluminous nature of the interview data, Creswell [25] advices that only excerpts that had information relating to the impact of integrating socio-economic activities of the local community into chemistry lessons were extracted from the transcript. Creswell [25] advises researchers to disregard some pieces of qualitative data that may be deemed not to be important to the research questions. The following were the extracts of the discourse during the interview:

> ***Interviewer***: Describe how you have felt learning at the brewer/charcoal burner's factory.
> **Respondent A**: As for me, I am very happy to be here because I have seen things I have never seen before. I have just experienced this and, e-eh- e-eh, when I complete my education I can have an opportunity to start a business like this one and start earning money from it. Yes!
> **Respondent B**: It is fantastic because we have applied the knowledge that we learn in class. And we have come to see for ourselves instead of only writing notes in class. We have come to see how they manufacture the ethanol which is called Kachasu. So it will be easier for us to remember in the examinations because we will be reciting what we have seen here.
> **Respondent F**: It is enjoyable here than in class.

From respondents' point of view, learning at the economic sites was evoked different themes. For example, respondents A, B and F said it were happy to be at the economic sites. They gave some reasons for their joy. For example, respondent A was happy because she witnessed something she had not seen in her life. This is somehow puzzling because the phenomenon was emanating from her community. She also appreciated the learning activity because it proved to her that chemistry knowledge and its applications could be a source of income. Respondent B appreciated the marrying of the theory learnt in class with the practicality of concepts in real life situations. Learners observed how the concepts they learnt in class were put to practical use. They witnessed ethanol and charcoal being practically produced. This has the potential to make learners commit the concepts to long-term memory and it would enable them pass national examinations with less difficulties. The other reason could be its adventurous nature. It can, therefore, be stated that taking learners out to the economic sites was worthwhile. This was supported by the better results that were gotten by the treatment groups when they visited the economic sites. This was in agreement with Bruner [19] who contends that interest in the learning material is a source of motivation to learners.

**Interviewer***:* You have learnt about fermentation/incomplete combustion through lecture and group discussions in class as well as by visiting the Kachasu/charcoal manufacturer. Which method do you think is better for your learning?
**Respondent C**: I think learning through practicing is better because it catches learner's attention.
**Respondent D**: Coming to the village is better because we see what is happening. For example, we have seen bubbles being produced during fermentation.
**Respondent E**: Sir, here it is better because we are seeing with naked eyes than in class.
**Respondent G**: I think going out for a visit to witness what is happening is better because we learn more, we get to ask the brewer questions and we get the answers.
**Respondent B**: As for me it is both learning in school and coming to visit because we learn in school, the teacher explains and when we come here we will be like, oh, this is what the teacher was talking about in class. So it will be easier for us to remember. Doing both theory and practice is a better idea for us to understand.

The learners' responses could be summarized in one sentence 'learning through real life objects was better for them'. Real life objects enabled learners to use their sight to see how things happened at the economic sites. Dale [32] argues that learners learn more when they involve more than one sensory organ in the learning process. Involving learners in the learning process through varied sensory organs catches their attention to the maximum. The sensory organs work in synergy to bring about the desired learning outcome. Learners at the economic sites did not only listen to the specialists' explanations, but they also saw bubbles being produced, signifying the production of ethanol.

Participants were also able touch the raw materials and the end products. They helped the brewer pound the malt as well as the mixing the raw materials. In charcoal production, they helped the charcoal burner make the kiln and they experienced how the entrance of excessive air (oxygen) in the kiln was traditionally restricted; by covering the kiln with soil.

> ***Interviewer**:* Many pupils believe that people in the village have no knowledge of applications of chemistry in daily life. Do you believe in this as well? Explain.
> **Respondent H**: For me, I have known today that chemistry applications are present in the village. Previously I did not know that it was there, but I have known now.'
> **Respondent I**, There is chemistry in the village because what they do here is what we learnt in class, so there is chemistry in the village.
> **Respondent G**: There is chemistry in the village. But it is just that we do not just know that they do it. In fact, they do it every day, but they just do not know that it is chemistry.

Some learners did not know that chemistry knowledge and its applications were practiced in their villages. All they knew was that chemistry was an alien subject only practiced in a laboratory. For example, respondent H confessed that he did not know despite the vast amount of chemistry applications that obtained in his community. Others somehow knew that chemistry applications were present in the villages, for example, respondent I and G. However, it seemed that respondent I came to know that chemistry applications were rampant in their community after lecture and discussion learning in class. It can be speculated that the respondent did not know prior to classroom learning. This can be tied together with what respondent G said above. He said that chemistry applications are practiced in the villages, but the villagers are just not aware of that it was similar to the chemistry learnt in schools. It was important for learners to realize that chemistry applications were practiced in their villages since learners would appreciate that chemistry knowledge and applications were indigenous. This would make them claim ownership of the subject and its vast applications, and they would stop thinking that chemistry was imported from western countries. This would result in positive attitude and performance might improve as well.

## DISCUSIONS AND IMPLICATIONS

In Zambia, the grade 12 national results for science and chemistry in particular have not been impressive. Hence, this study was designed to investigate the impact of integrating socio-economic activities of the local community into chemistry lessons at Malambanyama Day Secondary School. Mixed method research design in form of a case study was used to study fermentation and incomplete combustion of wood. Learners were randomly selected and assigned to the control and treatment groups. The two groups learnt together using the LDM, while the treatment group was later taken to the SEA site, leaving out the control group untreated.

Results indicated that the attitude of learners at pre-intervention was neutral and positive at post-intervention. At post-test 1 the chemistry assessment mean score for the treatment group was significantly higher than for the control group. However, at post-test 2, the chemistry assessment mean score for the treatment group was higher than for the control group, though not significantly. Generally, both quantitative and qualitative results showed that integrating SEA of the local community into chemistry lessons improves attitude, subject conception and academic performance. These results were in agreement with the findings of Nashon and Anderson [10] and Chibuye and Singh [33].

It seemed that learners who were treated with the SEAs were able to intelligently connect the knowledge they learnt at the sites with the chemistry concepts that they learnt in class, hence, the better performance. Learners also realized that applications of chemistry was part of their daily life, and this made them believe that chemistry was not an alien subject. This probably challenged them to change their attitude and they began to believe in their own potential, and eventually better results were recorded from the treatment groups. These findings agree were in agreement with the results obtained by Nashon and Anderson [10] in Kenya where learners in a qualitative study confessed that the use of ethno chemistry practices in the teaching and learning of chemistry helped them to understand chemistry more than when LDM were used. The learners stated that LDM only made them pass the national examinations without life-long learning.

**Limitations**

Some limitations were encountered during this study. Absenteeism of learners from class was rampant. Some learners were absent at different stages of the study. Some were absent during chemistry assessments such as at pre-test and post-tests. Others were absent during administration of pre or post-intervention of attitude questionnaire. This could have adversely affected the results and their interpretations. For example, at post-test 1 only 12 out of 21 participants took the test. If the 9 learners who were absent were among the gifted learners in group 2, it meant that the group performance mean score (54.58) could have been higher than that. This meant that the results and their interpretation could have been different.

Also, the topics under study were not part of the scheme of work for the term at this school; hence, afternoon periods were used for the study so that the normal learning could not be disturbed. Due to limited time and funds, only two SEA sites were visited. There was need to visit more than two SEA sites in order to establish consistency of results (triangulation).

In trying to mitigate the impact of these challenges, absenteeism was reported to the school administration who warned the learners against absenteeism. However, this could have been against research ethics because the true reasons for learners' absenteeism was not known. May be this was a way of withdrawing from the study. At the same time, school authorities allowed the study to be done in the morning during chemistry periods in order to counter absenteeism.

The other challenge was that there was a high chance that participants in the treatment and control groups were communicating on what they were learning at the sites before administering the tests. This could have influenced the performance mean score of the control group. This could be the reason why the performance mean difference between the control and the treatment groups at post-test 2 was not statistically significant.

**Implications**

1) Results from the current study mean that educators must take advantage of the socio-cultural knowledge that may serve as pre-requisite knowledge for learners during their lessons.
2) This also implies that curriculum developers must consider including a good number of socio-cultural scientific SEA of different ethnic groupings in the school curriculum so that lessons can become more meaningful to the learners.

3) Teacher education institutions must also have a deliberate structure for encouraging student teachers to be innovative in the use of socio-cultural related knowledge base as pre-requisite knowledge for learners to better understand the concepts.

There is also need to re-do this study using more than two socio-economic activity sites in order to establish consistency of results.

**Conclusion of the study**

The purpose of this study was to find out the impact of integrating SEA of the local community into the chemistry lessons. The overall finding in this study was that incorporating SEA of the local community into chemistry lessons leads to improved learner attitude, conception and academic performance. This was exemplified by the better performance of the treatment group than the control group. The better performance was most likely triggered by the economic value of chemistry which could have motivated learners to work had because applications of chemistry were sources of livelihood. This study has contributed the socio-economic aspect of chemistry to the body of knowledge.

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