



The Effects Of Laboratory Method On Mathematics Performance Among Secondary School Students In Kapseret Sub County, Kenya

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ABSTRACT

Mathematics is compulsory for all learners in secondary schools as recommended by the Kenya Institute of Curriculum Development, 2010. The performance of mathematics has been consistently low and one of the reasons is due to lack of Mathematics laboratory. The study sought to determine Mathematics performance among secondary school's students. The study instruments that were used included pre-test, post-test non-equivalent group experimental design, questionnaires and interview schedule. The researcher sampled 298 students and 26 teachers who took part in the study. The Form two students were selected to participate in the study. A sample size that represented the study population was selected using simple random sampling and purposive sampling while stratified sampling was used to select the schools. The study used the Solomon Four-Group design where two groups were formed, one experimental and one control group. The experimental group entered laboratory instructional strategy method while the control group entered conventional instructional strategy method. The respondents were assigned in their complete classes to four groups; experimental groups 1 and 3, and control groups 2 and 4. All the groups were taught the same content of the reflection and congruence. However, groups 1 and 3 were taught using laboratory method while groups 2 and 4 were taught by conventional methods. Groups 1 and 3 were pre-tested prior to the implementation of the laboratory method treatment. Teachers who took part in the study were inducted prior to the study by the researcher for period

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of three weeks. Mathematics Achievement Test 1 and Mathematics Achievement Test 2, questionnaires and interviews were used to collect data. SPSS were used to aid in data analysis. Chi-square tests were used to establish relationships. The study findings indicated that the laboratory method arouses the learners' interest, increased learner participation, boosted on the performance, enabled learners to develop the necessary skills for more advanced study research and promoted the development of scientific thinking. The study recommends that there is need for teachers to use laboratory method which ensures that learners are involved and engaged more in doing Mathematics activities and teachers have to be trained on the use of the laboratory method.

Introduction

Globally, Mathematics is regarded as core subjects in the school curriculum (Suleiman & Hammed, 2019). A nation's socioeconomic development is greatly influenced by its basis in scientific and technological knowledge (Chand et al., 2021). According to a study by Sa'ad et al. (2014), without a solid understanding of Mathematics, neither education nor daily living can run well. However, poor arithmetic performance has emerged as a persistent issue that could hinder these developing nations from attaining their developmental objectives (Mabena et al., 2021).

For careers in the sciences, such as engineering, pharmacology, environmental science, and technology, mathematics study is a necessity for secondary education in Kenya. Mathematics, according to Maass et al. (2019), is the foundation of science and technology and



performs several roles that are crucial to the operation of every field of the scientific and technical community. It is a subject, by Asad et al. (2020) and Nkirote & Thinguri (2020) that enables a Learner to have an appropriate understanding and interpretation of general scientific and technological principles, which leads to technology. The importance of Mathematics in science, technology, and invention (STI) has been widely recognized by the Kenyan government through the 2030 vision (Daniels, 2017).

Despite the highly applauded and acknowledged significance of Mathematics and the fact that it is a prerequisite for the majority of subjects, poor achievement and lack of interest in Mathematics (and STEM) among students continue to be a problem in both developed and developing countries' schools, colleges, and universities (Sharma et al., 2018; 2019). According to students' perceptions of the topic in schools, Mathematics is still one of the most difficult (Brown et al., 2020). Both internal exams and the Kenya Certificate of Secondary Education have often shown poor math performance (Ochieng et al., 2017). According to KNEC (2021), math scores have historically lagged behind those in other science courses. Students routinely do poorly on internal and external Mathematics assessments, according to Desoete et al. (2019), Eyong et al. (2020), and Njoroge (2022).

There are numerous explanations for why students perform poorly in Mathematics classes. Researchers have identified several factors that contribute to poor academic performance in Mathematics, including student attitudes toward the subject, a lack of teaching experience, the state of the economy, the use of ineffective teaching strategies, and teacher and student attitudes (VaraidzaiMakondo & Makondo, 2020). Faith (2020) a different researcher, identified several factors that contribute to subpar Mathematics achievement, including insufficient teaching staff, student absenteeism, low entry scores, subpar assessment systems, and subpar teaching methods. Students' low performance in math classes is the result of a lack of practical applications and insufficient skill and

knowledge acquisition, which demotivates them from pursuing further study in the field (Lave, 2021). The researcher has noted that Kapseret Sub-county has not been spared to this national predicament.

Table 1.1 represents the Kapseret Sub-County KCSE performance for the past years (2017-2021).

Table 1.1: Kapseret Sub-County KCSE performance for the past years (2017-2021)

Year	Very good	Good	Average	Poor	Entry	Mean Score	Grade
2018		106	284	1109	1625	3.60	D+
2019	157	173	350	1367	2047	3.67	D+
2020	161	206	386	1409	2147	3.37	D
2021	72	128	222	1101	1523	3.25	D

(Source: SCDE, 2021)

Proper solutions to improve learner performance in mathematics depend on knowing the causes of poor performance in the subject. One of the solutions to avert poor performance of mathematics is to change instruction methods. Recently, laboratory method has been proposed to aid mathematics performance as opposed to conventional method. Laboratory method refers to that method in which students learn Mathematics by carrying out mathematical practical's in a Mathematics room/ laboratory. The laboratory is highly helpful in subjects like Biology, Chemistry, and Physics since it allows students to engage in practical activity, which inspires them to learn more (Affeldt et al., 2017). According to Njoroge (2022) problem-solving methods, such as using a laboratory to teach and learn chemistry, can help students improve their ability to communicate, work in a team, and access and utilize knowledge. Mathematics laboratory instruction can help students create concepts through experience with physical things (Okeke & Okigbo, 2021).

In Kenyan secondary schools, where there are no Mathematics laboratories, the laboratory method is not used to teach Mathematics; rather, it is only taken into consideration for other Science subjects, which is one of the reasons for low achievement in Mathematics (Okeke & Okigbo, 2021). Therefore, the use of such teaching techniques in Mathematics instruction is necessary to raise student achievement.

Methodology

Study Area

The study was conducted in Kapseret Sub County in Uasin Gishu County. Kapseret Sub-County has five wards and estimated surface area of about 451 square kilometers and approximately 121,178 individuals (Kenyacradle.com). It has County has approximately 26 secondary school.



Figure 1.1: A map of the study area in Kenya

Research Design

Solomon's Four Group Design was used in the study's experimental procedures. This is due to the fact that secondary school classes that have already been formed continue to exist as complete units and that school authorities do not let such classes to be disbanded and reconstituted for study (Akhtar, 2016). The chosen schools were divided into intact groups and randomly assigned to the treatment and control conditions.

Table 1.2: Solomon four groups

Group	Pre test	Treatment	Post test
Experimental 1	Yes	Lab Method	Yes
Experimental 2	No	Lab Method	Yes
Control 1	Yes	Conventional Method	Yes
Control 2	No	Conventional Method	Yes

Target Population, Sample Size and Sampling Techniques

The target population comprised of all the form two's students where topic on Reflection and Congruence is taught. The students are important because they provided evidence of laboratory methods enhancing good performance among students when compared to conventional methods. The respondents were selected using stratified random sampling, simple random sampling and purposive sampling. The schools were first stratified (extra county, county and private secondary) then simple randomly selected to take part in the study within a strata. The researcher sampled 20 schools out of the possible 26 secondary schools within the sub-county, 10 schools were used as control and 10 experimental.

The students were sampled using simple random method; 298 were selected to take part in the study. Teachers were sampled using purposive sampling method and total of 26 teachers took part in the study. The students were distributed in control 1 & 2 and experiment 1 & 2. The total sampled respondents were 324 individuals.

Research Instruments

Mathematics Achievement Test 1 and Mathematics Achievement Test 2, questionnaire and interview schedule were used to collect data on the use of laboratory method on Mathematics performance.

Data Analysis

Data collected was analyzed with the help of Statistical Package for Social Science (SPSS) software (version 21). Data collected through questionnaires was coded, analyzed and relationships between variables derived using cross-tabulation. Descriptive statistics were used to determine frequencies and percentages while inferential statistical analysis using the chi-square test was used to determine whether expected frequencies differ from the actual frequencies.

Results

Two hundred and ninety eighth learners participated in this research study. In terms of gender male 154 (51.92%) and female 144 (48.08%) learners had almost equal proportion hence very low gender disparity. Twenty six teachers of Mathematics took part in the study; there were 14 (53.85%) females and 12 (46.15%) males.

Table 1.3: Demographic characteristics

Respondents	Sampled	Participated	Percentage respondent
Teachers	26	26	100%
Students	900	298	33%

Effects of laboratory method on Mathematics performance

The experiment was done by inducted teachers. All the teachers who participated in the study were inducted by the researcher, who then helped in monitoring of the teaching. The study took a whole month. The selected schools were both boarding and day school; to avoid contamination the student on experimental were caution on sharing of the information with those of control. During the study both conventional method and laboratory methods were used. The students were assumed to have the same capabilities to solve and understand the Mathematics. The post-test finding indicated the experimental students' performance was higher than control that used the conventional method. The laboratory method helped students retain the learned concept longer ($p < 0.05$), understand the concept better than before ($p < 0.05$), removing abstractness ($p < 0.05$), boosted the performance ($p < 0.05$), increased effective teaching and learning ($p < 0.05$), builds confidence in learning subject ($p < 0.05$), enables the learners develop skills necessary for more advance study of research ($p < 0.05$), promoted the development of scientific thinking in students ($p < 0.05$) and enabled the students to answer the given questions correctly ($p > 0.05$). The laboratory methods did not help students answer the given questions



correctly ($p > 0.3926$).

Table 1.4: Effects of laboratory method on Mathematics performance

Statement	Respondents	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Chi-Square (χ^2)
Made the students to retain the learned concept longer	Learners	32 (15.38%)	163 (78.37%)	1 (0.48%)	8 (3.85%)	4 (1.92%)	$\chi^2 = 218.45$ d.f.=4 p= 0.0001
	Teachers	4 (15.38%)	19 (73.08%)	2 (7.69%)	1 (3.85%)	-	$\chi^2 = 125.36$ d.f.=3 p = 0.0001
Enabled the learners to understand the concept better than before	Learners	67 (32.21%)	129 (62.02%)	2 (0.96%)	8 (3.85%)	2 (0.96%)	$\chi^2 = 144.3$ d.f.=4 p = 0.0001
	Teachers	8 (30.77%)	16 (61.54%)	1 (3.85%)	1 (3.85%)	-	$\chi^2 = 91.47$ d.f.=3 p = 0.0001
Helped in removing abstractness	Learners	61 (29.33%)	113 (54.33%)	3 (1.44%)	24 (11.54%)	7 (3.37%)	$\chi^2 = 97.5404$ d.f.=4 p = 0.0001
	Teachers	2 (7.69%)	14 (53.85%)	6 (23.08%)	3 (11.54%)	1 (3.85%)	$\chi^2 = 81.44$ d.f.=4 p = 0.0000
Boosted the performance	Learners	48 (23.08%)	142 (68.27%)	1 (0.48%)	8 (3.85%)	9 (4.33%)	$\chi^2 = 161.23$ d.f.=4 p = 0.0001
	Teachers	6 (23.08%)	18 (69.23%)	1 (3.85%)	1 (3.85%)	-	$\chi^2 = 112.86$ d.f.= 3 p = 0.0001
Increased effective teaching and learning	Learners	52 (25.00%)	112 (53.85%)	6 (2.88%)	24 (11.54%)	14 (6.73%)	$\chi^2 = 85.15$ d.f.= 4 p = 0.0001
	Teachers	7 (26.92%)	14 (53.85%)	1 (3.85%)	3 (11.54%)	1 (3.85%)	$\chi^2 = 89.04$ d.f.= 4 p = 0.0001
Builds confidence in learning subject	Learners	63 (30.29%)	104 (50.00%)	8 (3.85%)	18 (8.65%)	15 (7.21%)	$\chi^2 = 77.30$ d.f.= 4 p = 0.0001
	Teachers	8 (30.77%)	13 (50.00%)	1 (3.85%)	4 (15.38%)	-	$\chi^2 = 48.08$ d.f.= 3. p = 0.0001
Enables the learners develop skills necessary for more advance study of research	Learners	52 (25.00%)	124 (59.62%)	8 (3.85%)	8 (3.85%)	16 (7.69%)	$\chi^2 = 114.03$ d.f.= 4. p = 0.0001
	Teachers	6 (23.08%)	18 (69.23%)	1 (3.85%)	1 (3.85%)	-	$\chi^2 = 112.86$ d.f.= 3. p = 0.0001
Promoted the development of scientific thinking in students	Learners	53 (25.48%)	137 (65.87%)	2 (0.96%)	5 (2.40%)	11 (5.29%)	$\chi^2 = 152.55$ d.f.= 4 p = 0.0001
	Teachers	8 (30.77%)	18 (69.23%)	-	-	-	$\chi^2 = 14.44$ d.f.= 1 p = 0.0001
Enabled the students to answer the given questions correctly	Learners	32 (15.38%)	45 (21.63%)	43 (20.67%)	33 (15.87%)	55 (26.44%)	$\chi^2 = 4.100$ d.f.= 4. p = 0.3926
	Teachers	3 (11.54%)	6 (23.08%)	12 (46.15%)	5 (19.23%)	-	$\chi^2 = 26.00$ d.f.= 3 p = 0.0000



Standardized Mathematics Achievement test (MAT) pre- test control and experimental; for the extra county school, the pre-test control mean mark was 11.09ffl1.21 while the pre-test experimental was 11.91ffl1.35 with no significant difference between pre-test control and pre-test experimental ($t = -3.0514$, $p = 0.2354$). For the County Secondary school, MAT for the control pre-test was 7.24.38ffl0.83 while the experimental pre-test was 8.10ffl1.08 with no significant difference between the two ($t = 1.9137$, $p = 0.2310$). For the private school, the pre-test control mean mark was 9.0ffl1.31 while the pre-test experimental was 10.44ffl1.27 with no significant difference between pre-test control and pre-test experimental ($t = -3.1405$, $p = 0.3534$).

Table 1.5: Pre-test for control and experimental Standardized Mathematics Achievement test (MAT)

	Pre-test control mean mark [%]±SE	Pre-test experimental mean mark [%] ±SE	Students t-test	p-value
Extra County	11.09±1.21	11.91±1.35	3.0514	0.2354
County	7.24.38±0.83	8.10±1.08	1.9137	0.2310
Private	9.0±1.31	10.44±1.27	-3.1405	0.3534

The Standardized Mathematics Achievement Test (MAT) post-test control and post-test experimental yielded the highest mean score (23.08ffl1.96), which was significantly higher than the post-test control ($t = -23.1253$, $p = 0.0013$), which recorded a mean score of 18.45ffl1.74. The highest mean score in the county school category, 13.13ffl1.22, came from the post-test experimental group and was noticeably higher than the post-test control group's (9.38ffl1.38; $p < 0.05$) mark. The private school means under study showed the same. Different types of schools, which are mostly influenced by infrastructure development and entry marks could be the cause of the disparity in means. Hypothesis (H01) anticipated association absence between student performance and laboratory method. The findings indicate a significant correlation between student performance and laboratory method ($p < 0.05$), rejecting the null hypothesis.

Table 1.6: Post-test control and post-test experimental Standardized Mathematics Achievement test (MAT)

	Post-test control mean mark [%]	Post-test experimental mean mark [%]	t-test	p-value
Extra County	18.45±1.74	23.08±1.96	-23.1253	0.0013
County	9.38±1.38	13.13±1.22	-21.1643	0.0021
Private	9.94±1.22	12.99±1.29	-33.9463	0.0015

Discussion

Laboratory methods of teaching Mathematics have shown to greatly influence student performance. It has proven that student is able to retain the learned concept longer when taught using the method. Moreover, student understanding of the concept has been made better than before when using conventional method understand the concept better than before. The finding also agrees with those of Okeke & Okigbo (2021), they stated that laboratory instruction help students create concepts through experience with physical things. This is consistent with Uzezi & Zainab (2017) conclusion that "activity-oriented learning" helps students understand and retain information because they actively engage in lessons through laboratory experiments, question-answering opportunities, and other opportunities to explore, justify, and elaborate their viewpoints.

The finding also indicated that laboratory method in in removing abstractness. This is consistent with Desoete et al. (2019) they stated that Mathematics laboratories provided quick access, eliminated abstraction, and improved effective teaching and learning. Also, Hadar & Tirosh (2019) and McCulloch et al. (2018) found out that Mathematics laboratory will help to lessen the abstract nature of the subject and enable students to grasp concepts. The finding has shown that Mathematics laboratory boost the performance; similar finding by Evans et al. (2022) and Hernández-de-Menéndez et al. (2019) demonstrated that the Mathematics Laboratory way of teaching and learning mathematics was superior to the lecture method in terms of student achievement.

The results show it increases effective teaching and learning and builds confidence in learning subject by students. The finding agrees with those of Das (2019); Njoroge (2022); Okeke & Okigbo (2021) the state that Mathematics lab improves students' capacity to complete their assignments and engage in other activities that offer active mathematical experiences using their senses. The finding also showed that the method enabled the learners develops skills necessary for more advance study of research and also promoted the development of scientific thinking. The finding by Evans et al. (2022); Hassler Hallstedt et al. (2018); Njoroge (2022) indicated that laboratory work in mathematics gives students the necessary practical skills. The finding is similar to those of Hwa (2018) where the lecture style used in schools isolates pupils from one another, which causes a high failure rate in the sciences and Mathematics.

The Standardized Mathematics Achievement Test (MAT) post-test control and post-test experimental yielded the highest mean score, which was significantly higher than the post-test control. Finding by (Hadar & Tirosh, (2019); Hernández-de-Menéndez et al. (2019); Hwa, 2018) are



similar to the researchers finding. They have indicated that Mathematics laboratory improves performance. The finding also agrees with Njoroge (2022) when a teacher adapts their teaching style to one that is more student-centered, good improvements occurs.

Conclusion

The study shows that students' total mean mathematical achievement was considerably impacted by the laboratory method of instruction. The experimental group had higher mean achievement as compared to the control group, which received conventional Math education. The laboratory method of instruction had a considerable impact on students' mathematical performance for the topics of reflection and congruence, according to both teachers and students. This is attributable to the method's ability to assist students to retain new information for longer periods, help them understand it more thoroughly than previously, help eliminate abstractness, improve performance, allow for the use of sophisticated tools, and let students practice new abilities. The Standardized Mathematics Achievement Test (MAT) pre-test experimental group showed significantly superior performance than the control group in the theme of reflection and congruence, according to the assessment of student performance for the three types of schools.

Recommendation

Teachers of Mathematics should include the laboratory method as one of the methods used in the topics of reflection and congruence as well as other mathematics-related topics. In order to ensure that students engage in the laboratory method to improve performance in an examination setting more frequently, practical examinations should be introduced in all classes.

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References

- Affeldt, F., Tolppanen, S., Aksela, M., & Eilks, I. (2017). The potential of the non-formal educational sector for supporting chemistry learning and sustainability education for all students—a joint perspective from two cases in Finland and Germany. *Chemistry Education Research and Practice*, 18(1), 13–25.
- Brown, S., Naiker, M., Sharma, B., Wakeling, L., Johnson, J., Mani, J., ... & Khan, N. (2020). Attitudes towards science among senior secondary students in Fiji. *Waikato Journal of Education*, 25(1), 57–72.
- Chand, S., Chaudhary, K., Prasad, A., & Chand, V. (2021). Perceived causes of students' poor performance in mathematics: A case study at Ba and Tavua secondary schools. *Frontiers in Applied Mathematics and Statistics*, 7, 614408.
- Daniels, C. (2017). Science, technology, and innovation in Africa: conceptualizations, relevance, and policy directions. What do science, technology and innovation mean from Africa.
- Das, K. (2019). Significant of mathematics laboratory activities for teaching and learning. *International Journal on Integrated Education*, 2(5), 19–25.
- Desoete, A., Baten, E., Vercaemst, V., De Busschere, A., Baudonck, M., & Vanhaeke, J. (2019). Metacognition and motivation as predictors for mathematics performance of Belgian elementary school children. *ZDM*, 51(4), 667–677.
- Evans, T., Mejía-Ramos, J. P., & Inglis, M. (2022). Do mathematicians and undergraduates agree about explanation quality? *Educational Studies in Mathematics*, 1–23.
- Eyong, E. I., Ugada, C., & Aminu, A. (2020). Indicators of Improved Achievement of Students' in Mathematics. *The Universal Academic Research Journal*, 2(1), 29–37.
- Faith, K. (2020). Factors contributing to poor performance in mathematics by students. A case study of Ndemi Secondary Schools in Kipipiri Subcounty, Nyandarua County.
- Hadar, L. L., & Tirosh, M. (2019). Creative thinking in mathematics curriculum: An analytic framework. *Thinking Skills and Creativity*, 33, 100585.
- Hernández-de-Menéndez, M., Vallejo Guevara, A., & Morales-Menendez, R. (2019). Virtual reality laboratories: A review of experiences. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, 13(3), 947–966.
- Hwa, S. P. (2018). Pedagogical change in mathematics learning: Harnessing the power of digital game-based learning. *Journal of Educational Technology & Society*, 21(4), 259–276.
- Lave, J. (2021). The Culture of Acquisition and the Practice of Understanding 1. In *Situated cognition* (pp. 17–35). Routledge.
- Maass, K., Geiger, V., Ariza, M. R., & Goos, M. (2019). The role of mathematics in interdisciplinary STEM education. *ZDM*, 51(6), 869–884.



- Mabena, N., Mokgosi, P. N., & Ramapela, S. S. (2021). Factors contributing to poor learner performance in Mathematics: A case of selected schools in Mpumalanga province, South Africa. *Problems of Education in the 21st Century*, 79(3), 451.
- McCulloch, A. W., Hollebrands, K., Lee, H., Harrison, T., & Mutlu, A. (2018). Factors that influence secondary mathematics teachers' integration of technology in mathematics lessons. *Computers & Education*, 123, 26–40.
- Njoroge, G. (2022). Demystifying Mathematics: Handling learning difficulties in Mathematics among low achievers in Kenyan schools. *Journal of Language, Technology & Entrepreneurship in Africa*, 13(1), 75–96.
- Nkirete, V., & Thinguri, R. (2020). Influence of teachers' motivation on learning outcomes among pre-primary learners in maara sub county, kenya. *African Journal of Education and Practice*, 6(2), 33–43.
- Ochieng, K. R., Kiplagat, P., & Nyongesa, S. (2017). Influence of teacher competence on mathematics performance in KCSE Examinations among public schools in Nyatike Subcounty, Migori County Kenya.
- Okeke, J. C., & Okigbo, E. C. (2021). Effect of generative learning model on secondary school students' achievement and retention in algebra. *South eastern journal of research and sustainable development (sejrsd)*, 4(2), 32–45.
- Sa'ad, T. U., Adamu, A., & Sadiq, A. M. (2014). The causes of poor performance in mathematics among public senior secondary school students in Azare metropolis of Bauchi State, Nigeria. *Journal of Research & Method in Education*, 4(6), 32.
- Sharma, B. N., Nand, R., Naseem, M., Reddy, E., Narayan, S. S., & Reddy, K. (2018, December). Smart learning in the Pacific: Design of new pedagogical tools. In *2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)* (pp. 573–580). IEEE.
- Sharma, B., Prasad, A., Narayan, S., Kumar, B., Singh, V., Nusair, S., & Khan, G. (2019, December). Partnerships with governments to implement in-country science programmes in the South Pacific region. In *2019 IEEE Asia-Pacific Conference on Computer Science and Data Engineering (CSDE)* (pp. 1–6). IEEE.
- Slieman, T. A., & Camarata, T. (2019). Case-based group learning using concept maps to achieve multiple educational objectives and behavioral outcomes. *Journal of Medical Education and Curricular Development*, 6, 2382120519872510.
- Suleiman, Y., & Hamed, A. (2019). Perceived causes of students' failure in mathematics in Kwara State Junior Secondary Schools: Implication for educational managers. *International Journal of Educational Studies in Mathematics*, 6(1), 19–33.
- Uzezi, J. G., & Zainab, S. (2017). Effectiveness of guided-inquiry laboratory experiments on senior secondary schools students' academic achievement in volumetric analysis. *American Journal of Educational Research*, 5(7), 717–724.
- Varaidzai Makondo, P., & Makondo, D. (2020). Causes of poor academic performance in mathematics at ordinary level: A case of Mavuzani High School, Zimbabwe. *International Journal of Humanities and Social Science Invention (IJHSSI)*, 9(1), 10–18.