

# Exploring Concrete Teaching Strategies Through Mathematics Laboratory Method to Enhance learner Achievements in Zambian Secondary Schools

## Abstract

Poor performance in Mathematics is an issue of great concern to various stakeholders. This study sought to investigate the effectiveness of the mathematics laboratory method on Grade 12 academic performance in Lusaka District. The specific objectives in this study were to; investigate the extent to which the Mathematics Laboratory Method enhances Grade 12 academic performance in Mathematics, establish the challenges teachers and learners encounter in teaching and learning Mathematics using the Mathematics Laboratory Method. The study employed a mixed method approach in which both qualitative and quantitative techniques were used to collect data. The sample size comprised of 132 participants consisting of 120 pupils representing both the control and the experimental group as well as 12 teachers from the 3 selected schools. Simple random sampling was used on the pupils and purposive sampling technique was used on the teachers. The control group and the experimental group were subjected to a pre-test of which an independent sample T-test was used to test the hypothesis. The results showed a mean pre-test score of 52% and 54% for the experimental and control group respectively, further statistical analysis revealed that there was no statistically significant difference in the pre-test results between the two groups. On the other hand, results for the post test, which was administered after the control group was taught using the traditional method of teaching and experimental using the mathematics laboratory method showed a statistically significant difference. The mean score for the post-test rose to 63.9667 and 68.1167 for the control and experimental group respectively. The analysis revealed that pupils who were taught using the Mathematics Laboratory Method performed better than those who were taught using the Traditional Method of teaching. The study therefore recommends the adoption of Mathematics Laboratory Method in Secondary Schools so as to enhance academic performance of the pupils.

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## Introduction

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### 1.0 Background and Literature

One of the goals of Education is to produce a learner capable of developing an analytical, innovative, creative and constructive mind. In order to realise that Mathematics plays a critical role in producing a learner of that calibre. The quest to produce a learner that is critical, creative and analytical in thinking and able to relate thinking to real life situations lies in the way Mathematics is taught (Carmichael, 2017). According Cockcroft (1982) to there is no definitive style of teaching Mathematics, however there are certain elements which need to be present in successful Mathematics teaching to all pupils of all ages. The elements cited in the report such as opportunity for practical work, investigational work consolidation and practice of fundamental skills routines culminate into the concept Known as the Mathematics Laboratory method.

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The Mathematics Laboratory method is commonly used today to refer to an approach to teaching and learning of Mathematics which provides an opportunity to the learners to abstract Mathematical ideas through their own experiences, that is to relate symbol to reality (Singh et al., 2018). It embraces the concept called “learning by doing” which is a very effective methodology in teaching and learning process as the experience gained meticulously remains permanently affixed in the minds of the children, so innovative teaching Aids and projects of Mathematics Laboratory plays a vital role in the conceptualisation process (Dewan, 2016). The abstract nature of Mathematics can be reduced through demonstrations and practical methods in a special room called the Mathematics Laboratory.

As defined by Kunwar (2020) states that the Mathematics Laboratory is a unique room or place with relevant and up-to-date equipment known as instructional materials designed for teaching and learning of Mathematics and other scientific or research work, whereby a trained and professionally qualified person (Mathematics teacher) readily interacts with learners (students) on specified set of instructions. It can also be defined as a place where students can learn and explore various Mathematical concepts and verify different mathematical facts and theories using varieties of activities and material. Alshafey and Aldosary (2021) described mathematics laboratory as “a place with hand tools and other equipment used by the student to experiment, search for mathematical concepts and reveal mathematical relationships, and the place may be the same classroom or a private room, depending on the conditions of the laboratory work practiced by the student.”

Matika (2015) state that Mathematics Education is a bedrock and indispensable tool for scientific and economic advancement of a person and a nation at large. Despite holding such a crucial role in human life, Mathematics Education suffers several setbacks due to the continued poor performance in National Examinations at all levels. The mean percentage marks for Mathematics have been 23.91, 26.34, 27.62, 25.46, 28.29 and 24.39 for the years 2021, 2020, 2019, 2018, 2017 and 2016 respectively. Many reasons have been attributed to the causes of poor academic performance in Mathematics. Amongst the causes of poor academic performance in Mathematics which the researchers have noted are attitudes of the learners towards the subject, lack of teaching experiences, economic conditions, lack of appropriate teaching methods and low motivation of teachers and attitudes. Suffice to note that among the reasons leading to poor performance is the pedagogical aspect (Nyaumwe, 2011)

The teaching of mathematics is a very complex activity and many factors determine the success of this activity. The nature and quality of instructional material, presentation of content, the pedagogical skills of the teacher, the learning environment, and motivation of students are all important and must be kept in view in any effort to ensure quality in teaching and learning of Mathematics. Likewise the Ministry of General Education embarked on STEM Education which advocates for a paradigm shift in the teaching of Mathematics from the ordinary traditional methods of teaching which is mostly lecture type and fails to equip students with skills and knowledge required for survival and Job Creation. The Traditional methods of teaching which mainly embrace deduction as opposed to induction are no longer adequate to meet the demands of modern mathematics Education and are responsible for high failure rate by the Grade 12 pupils (Alshafey & Aldosary, 2021).

Cicekci and Sadik (2019) established that the method of deduction was responsible for the dullness and monotony in the class and taxed the brain too much. All new teaching should be

started with inductive method and should end in deductive method. Inductive method is laborious and lengthy, but it leads to Knowledge discovery. We proceed from concrete to abstract and from known to unknown. The importance of the Mathematics Laboratory Method in the development of Mathematical concepts cannot be overemphasised as it has great potential to overcome the difficulties experienced in learning Mathematics due to its modern strategies for teaching Mathematics, transforming the role of the teacher from an active speaker to a facilitator and mentor of the teaching and learning process and this is what modern Education seeks (Alshafey & Aldosary, 2021). The Mathematics Laboratory Method advocates for demonstration as a medium of instruction for teaching and learning of Mathematics. Mushin et al. (2013) proposed that demonstrations may evoke the “wow” experience. This consequently can increase their curiosity and enhance their reasoning abilities.

Ado and Nwosu (2016) conducted a study on the influence of Laboratory Method on Students' Mathematical Creativity in Yenagoa Local Government Area of Bayelsa State. This study investigated the influence of laboratory method on students' mathematical creativity in junior secondary schools in Yenagoa, Bayelsa State. The study was guided by three research questions and three hypotheses. The Pretest- Posttest non-randomise control group design was adopted for the study. A sample of 122 students from two intact classes selected randomly was used for the study. The instruments for data collection were the Mathematics Creativity Test (MCT) and Students Attitude towards Mathematics Questionnaire (SAMQ). The data collected were analysed using mean and standard deviation, and the Analysis of Covariance (ANCOVA). The result indicated that Laboratory method of teaching significantly enhance students' creativity in mathematics. The method equally enhanced Mathematical creativity of both male and female students. Students' attitude towards Mathematics also influenced Mathematical creativity significantly. Among others, it was recommended that Mathematics teachers should explore the use of laboratory method in teaching various concepts in Junior Secondary School level.(Ado & Nwosu, 2016)

Nath and Binny (2018) conducted a study on the availability and Utilization of Laboratory Kits for Practical Teaching of Mathematical Skills in Chemistry. This study investigated the availability and utilisation of laboratory kits for practical teaching of mathematics in chemistry in Ahoada West local government area of Rivers State. A descriptive research design was adopted in carrying out this study. The population of the study was all public senior secondary I (SS1) chemistry students in Ahoada West education zone of Rivers State. A total of two hundred (200) chemistry students were used as a sample for the study which comprises one hundred and twenty (120) male, and eighty (80) female. Four research questions guided the study. The data were analyzed using frequency counts and percentages. A structured questionnaire was the instrument used for data collection, and the instrument was face validated by three experts. Reliability coefficient index of 0.76 was obtained using the test-retest method. The result revealed that the availability and utilization of laboratory kits in the sampled senior secondary schools were inadequate. Based on the result, it was recommended that the government at all levels of education should endeavor to make adequate provision of laboratory kits for the practical teaching of mathematics in chemistry, besides chemistry teachers, should ensure that students are introduced to the use of the few available apparatus during practical classes(Nath & Binny, 2018)

### 1.1 Statement of the Problem

Poor performance in Mathematics has attracted a lot of interventions such as homework policy, lesson study, remedial work, Continuing Professional Development and others.

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However, despite a number of interventions being put in place performance in Mathematics has continued to be extremely poor. In a presentation by the Examination Council of Zambia Mathematics Specialist at the (2019) ZAME Conference, the mean percentage mark at National level for 2016, 2017 and 2018 stood at 24.39, 28.29 and 25.46 respectively. The percentage of Candidates who got Grade one (distinction) stood at 6.24% whereas those who got Grade nine (fail) at 41.89%. Furthermore, Mathematics in general is increasingly becoming unpopular among the learners and detached from the real world despite being an interesting subject which can be learnt with a lot of enjoyment, pleasure and satisfaction because of its elegance and wide application to the real world. The failure rate could be attributed in the manner Mathematics is taught in most of the Secondary Schools in Zambia. The lack of mathematics laboratory and Mathematics teacher's non-use of laboratory technique in teaching mathematics is one of the major factors that contribute to poor achievement in mathematics by Secondary School students (Ogunkunle, 2014). Therefore, this study is aimed at examining the effectiveness of using the Mathematics Laboratory Method on Grade 12 academic performance.

## 1.2 Objectives

1. To investigate the extent to which the mathematics laboratory method enhances Grade 12 academic performance in Mathematics
2. To establish the challenges faced by Schools in establishing Mathematical laboratories.

## 1.3 Theoretical Framework

This Study is anchored on the theory of constructivism which advocates for “learners working out themselves”. Constructivism theory is a theory that postulates learners construct knowledge rather than just passively take in (Brandon & All, 2010). Thus, according to Jean Piaget's theory of cognitive development which suggests that learning is accomplished best using a hands-on approach. Learners learn effectively by conducting practical experiments themselves in order to arrive at dependable Knowledge from the inferences established as opposed to being told what the concept is (Applefield et al., 2000). The theory suggests that humans construct knowledge and meaning from their experiences. Constructivism is not a specific pedagogy (Scholnik et al., 2006). Constructivism theory is well placed for this study as the Mathematics Laboratory method is based on the concept that learners are active participants for their own learning journey as it prompts pupils to formulate their own questions, allows multiple interpretation and expressions of learning as well as encourage group work and use of peers as resources.

## 2.0 Methodology

### 2.1 Research Design

This study evolved a current triangulation design, this design involves a single study containing qualitative and quantitative data collection which is conducted at the same time. The purpose of this type of investigation is to validate the findings generated by each method through evidence produced by the other (Creswell et al., 2004). The study targeted three secondary schools within Lusaka district. These include David Kaunda secondary school, Kamwala Secondary School and Chilenje Secondary School. The schools were selected

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based on the performance of the pupils in mathematics in final examination. David Kaunda was in the category of schools that were recording excellent results in mathematics, while Kamwala was recording fairly good results and Chilenje was recording poor results.

## 2.2 Sample Size and Sampling Techniques

The study consisted a total sample size of 132, comprising 40 pupils from each of the 3 schools, (20 were in the experimental group and 20 in the control group). The qualitative sample comprised of 4 mathematics teachers from each school bringing the total to 12.

The study made use of probability sampling technique, specifically simple random sampling technique. Simple random sampling technique was employed on pupils. Thus, in order to select the pupils, the researcher obtained the lists of all names of the learners who are engaged in the learning process and serially name them. The same sequence of names were written on small pieces of paper, which were folded, and then subjected them to the draws of a hat. Only one piece of paper were picked at a time until the required sample is reached (n=40). The number on the piece of paper represented the name that were picked from the list as a sample.

## 2.3 Research Tools

*Pre and Post Test Questions:* In this study test questions were used on pupils of Mathematics to obtain qualitative data and the on the performance of the pupils. The sample size of pupils consisted of the control group and experimental group, 20 pupils were in the experimental group and 20 in the control group from each school.

*Semi-Structured Interview schedule:* Semi-structured interviews were used with teachers. The rationale behind the semi-structured interviews with the teachers was to have an in depth understanding, opinions, and views pertaining to the effectiveness of using the Mathematics Laboratory Method on Grade 12 academic Performance.

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## 3.0 Results

### 3.1 Objective One: The Extent to which the mathematics' laboratory Method Enhances Grade 12 Academic Performance in Mathematics.

The pre-post test was conducted on both the control group and experimental group. The Independent Sample T-Test was used to statically test the results.

#### Pre- Test of the control group and the experimental group

To ensure that the experimental group and the control group were within the same level of performance. A pre-test was conducted on both groups and the results were tested using an independent sample T-Test.

#### Hypothesis One:

**Null Hypothesis:** there is no statistically significant difference between the pre- treatment test scores between the experimental group and control group.

**Alternative Hypothesis:** There is statistically significant difference between the pre-treatment test scores between the experimental group and control group.

The results show that out of 100% the mean test score of 60 students in the control group was 54.05% and the experimental group recorded 52.15%.

**Table 1 : Group Statistics**

	Group Type	N	Mean	Std. Deviation	Std. Error Mean
Pre- Treatment Test Scores	Control group	60	54.0500	11.84136	1.52871
	Experimental group	60	52.1500	14.10953	1.82153

The significance of the variance of the means was tested by looking at the significance value of 0.426. Since  $0.426 \geq 0.05$ , we accept the null hypothesis and infer that there is no statistically significant difference between the pre-treatment test scores between the experimental group and control group

**Table 2 : 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
Pre-Treatment Test Scores	Equal variances assumed	2.016	.158	.799	118	.426	1.90000	2.37801	-2.80911	6.60911
	Equal variances not assumed			.799	114.553	.426	1.90000	2.37801	-2.81058	6.61058

**Post -Treatment Test Scores**

After the pre-test the experimental group was taught using mathematics laboratory while the control group was taught using the laboratory. The difference in the results were tested using the independent sample t-test.

**Hypothesis Two**

*Null Hypothesis:* There is no statistically significant difference between the post-treatment test scores between experimental group and control group.

*Alternative Hypothesis:* There is a statistically significant difference between the post-treatment test scores between the experimental group and control group.

Table 3 shows the post treatment mean score of 63.966 for the control group and post treatment mean score of 68.12 for the experimental group.

Table 3: post treatment mean score

**Group Statistics**

	Group Type	N	Mean	Std. Deviation	Std. Error Mean
Post-Treatment Test Scores	Control group	60	63.9667	11.96317	1.54444
	Experimental group	60	68.1167	10.72000	1.38395

The significance of the variance of the means was tested by looking at the significance value of 0.048. Since  $0.048 \leq 0.05$ , we accept the reject the null hypothesis and infer that there is a statistically significant difference between the post-treatment test scores between the experimental group and control group

Table 4 : Independent Samples Test

		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
Post-Treatment Test Scores	Equal variances assumed	.355	.553	-2.001	118	.048	-4.15000	2.07379	-8.25667	-.04333
	Equal variances not assumed			-2.001	116.607	.048	-4.15000	2.07379	-8.25717	-.04283

### 3.2 Analysis of Variance of the Means Between the Control Groups and Experimental Group

*Null Hypotheses:* There is homogeneity of means between the post treatment test scores of the control group and experimental group.

*Alternative Hypothesis:* There is no homogeneity of means between the post treatment test scores of the control group and experimental group.

The analysis of variance of the post-treatment test score between the experimental group and control group shows the sig value of 0.048 which is  $\leq 0.05$ . Hence, we reject the Null hypothesis and infer that there is no homogeneity of means between the post treatment test scores of the control group and experimental group.

On the other hand, the pre- treatment test score shows the significance value of .426 which  $\geq 0.05$ . Hence, we accept the Null Hypotheses and infer that There is homogeneity of means between the pre-treatment test scores of the control group and experimental group.

Table 5: ANOVA Table

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
Post-Treatment Test Scores * Group Type	Between Groups	(Combined)	516.675	1	516.675	4.005	.048
	Within Groups		15224.117	118	129.018		
	Total		15740.792	119			
Pre- Treatment Test Scores * Group Type	Between Groups	(Combined)	108.300	1	108.300	.638	.426
	Within Groups		20018.500	118	169.648		
	Total		20126.800	119			

Comparison of the Performance of pupils in the Three schools

Table 6 shows that David Kaunda Secondary school recoded the best results in both the pre and post-test, followed by Chilenje Secondary and lastly Kamwala Secondary.

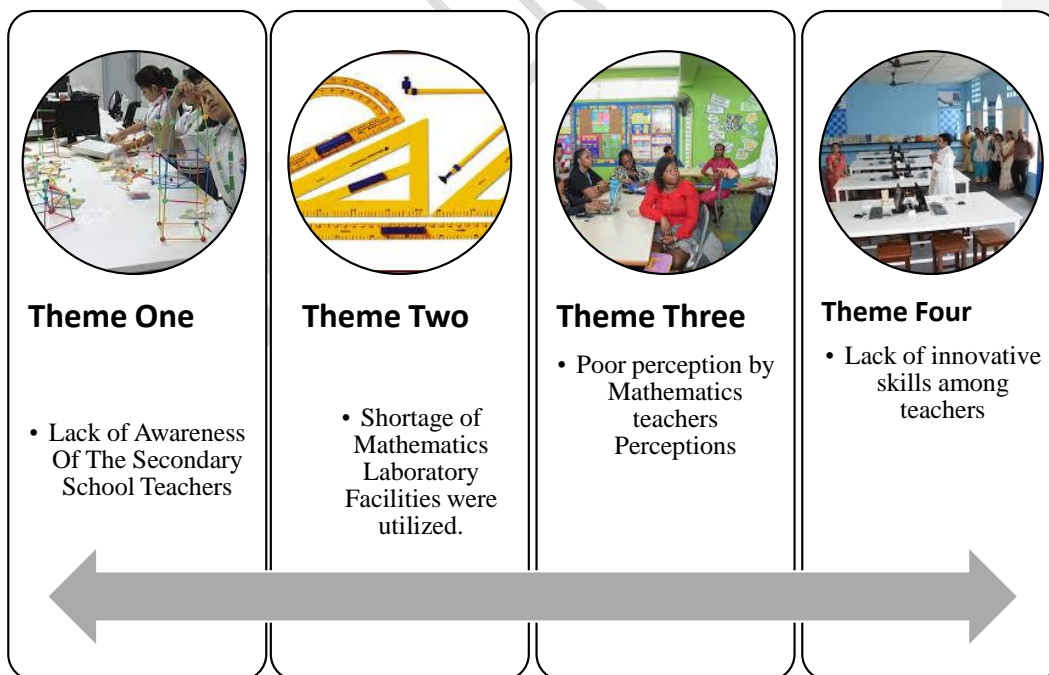
Table 6: Pre- Treatment Test Scores Post-Treatment Test Scores \* School

Pre- Treatment Test Scores		Post-Treatment Test Scores	* School
School		Pre- Treatment Test Scores	Post- Treatment Test Scores
Kamwala Secondary	Mean	48.1250	63.7000
	N	40	40
	Std. Deviation	13.80484	12.44104
David Kaunda Secondary	Mean	57.6750	67.9250
	N	40	40
	Std. Deviation	11.12721	11.38237
Chilenje Secondary	Mean	53.5000	66.5000
	N	40	40
	Std. Deviation	12.43651	10.47830
Total	Mean	53.1000	66.0417
	N	120	120
	Std. Deviation	13.00511	11.50111

### 3.3 Objective Two: Challenges Faced by Schools in Establishing Mathematical Laboratories.

During an interview with the teachers the following themes emerged as the key challenges faced by schools in establishing mathematics laboratories.

Figure 1 : Key challenges faced by schools in establishing mathematics laboratories



#### Lack of Awareness of the Secondary School Teachers

Awareness of the Mathematics laboratory method is one important aspect to teaching and learning of mathematics as it places emphasis on “learning by doing” as a panacea to the generalization of mathematical concepts and ideas. Pertaining to lack of awareness by Secondary School one of the mathematics teachers stated in an interview:

*“Most of the teachers lack awareness of the mathematics laboratory method and rarely use it. Very few teachers are aware of the mathematics laboratory method as such, they don’t even use it. Typical of us teachers, we teach according to the prescribed textbooks and no room for other method that will enhance pupil understanding. The mathematics laboratory method is not so common in Zambia and I doubt if at All there is any school using the mathematics laboratory method. It is common among us teachers to be stuck with the same routine of executing our work and no room for innovative change despite producing poor results”*

#### **Shortage of Mathematics Laboratory Facilities were utilized**

In order for the Mathematics Laboratory method to be utilized effectively, availability of the mathematics Laboratory facilities is cardinal. The mathematics laboratory method seeks to heighten the incorporation of properly designed teaching aids in the teaching and learning of Mathematics for easy conceptualization process

*“It is very difficult to find teaching aids for Mathematics in Schools, there are very few teachings and learning material for Mathematics found in Schools. Most schools do not have mathematical models for the teaching and learning Mathematics. In most cases Teachers do not value the usage of visual teaching aids for Mathematics”*

#### **Poor perception by Mathematics teachers Perceptions**

Perception by Mathematics teachers has a huge bearing on the success of a Mathematics lesson. A right attitude towards the usage of teaching aids as conduit for easy understanding of concepts is vital for a successful lesson

*“Most teachers think it’s impossible to teach Mathematics using the laboratory method, they see it as something impossible. Some teachers and pupils think that Mathematics is subject involving abstract solving and cannot be modelled into practical real-life experiences and they are stuck by textbook”*

#### **Lack of innovative skills among teachers**

The researcher also wanted to find out whether the teachers of Mathematics possess innovative skills. This is an essential element in ensuring that the Mathematics Laboratory Method is utilized in the absence proper Mathematical teaching aids

### **4.0 Discussion**

#### **4.1 The mathematics laboratory method enhances Grade 12 academic performance in Mathematics**

The result showed that laboratory method has a significant effect on student performance and retention. After the treatment, the findings have shown that students in the experimental group had a higher post-test mean scores in transformation than the control group. This shows that there is significant difference between the two groups in terms of performance and retention scores. The study revealed that the Mathematics Laboratory Method provides the students with learning experience enriched with in depth examples from environment;

students therefore had opportunities to engage in concrete activities that facilitate the development of their performance and retention. As suggested by Radovan and Makovec (2015), students tend to be more successful in tasks when they turn to their cultural environment for clues. This finding is in agreement to the finding of Ugada et al. (2018) who argues that the teaching of mathematics with Mathematics Laboratory Method will lead students to formation of concepts out of experience with concrete objects. Through the Mathematics Laboratory Method, the learning experience was related to the student's environment and this engendered their interest and motivation to engage in the relevant tasks the culminated to develop their performance.

The Mathematics Laboratory Method has also contributed to its relative efficacy in its activity-oriented nature. Activity oriented learning aids understanding and retention of information as noted by Ajewole et al. (2021) it ensures that learners participate actively in lessons through laboratory experiments, and answering question and also the opportunities to explore, explain and elaborate their views Hence, enhance the deep understanding of the subject by the student. The findings from this study therefore indicate that teaching transformation by the use of Mathematics Laboratory Method can enhance performance and retention of transformation among senior secondary school students.

#### **4.2 Challenges of Establishing Mathematics Laboratory**

The result of the study revealed that only the mathematics laboratory method was only used to a very low extent in the targeted schools. The average response from David Kaunda secondary school showed that the facilities were available at a low extent. This result is in similarity with the findings of Abasi (2018) which showed that students were of the opinion that there are poorly available mathematics laboratory kits for teaching and learning of mathematics. Also, Okigbo and Osuafor (2008) who stated that there are inadequate resources for teaching and learning of Science subjects in public secondary school in Nigeria

The study revealed that there was lack of awareness of the secondary school teachers on how to employ the math lab and achieve the desired results. Teachers agreed on the importance of the math laboratory and its necessity in the school as the teachers of the school where the laboratory was not available recommended the need to establish the laboratory so that it can be employed and to benefit from its components. These results are consistent with the study of Maschietto and Trouche (2010) who argue that the obstacles from the point of view of the teachers are mostly physical, which means the lack of equipment and geometrical tools that enable teachers to employ them in laboratory activities. Maschietto and Trouche (2010) further reveal that, few Mathematics laboratory facilities were utilized for pedagogical purposes as they had response mean greater than the criterion mean. The average response showed that the facilities were utilized at a low extent. Further analysis showed that students' opinion on the utilization of mathematics laboratory facilities for pedagogical purposes in secondary schools was irrespective of their gender.

Other challenges from the interview of teachers also showed that there was lack of materials and equipment to carry out practical work. At the same time, it is possible that some of these materials and equipment may be locked up in the school laboratory store without teachers being aware of their existence. The conditions under which many teachers' function do not engender any enthusiasm to use the laboratory method of teaching science even where they know that these materials. Most of laboratory classroom are not equipped with work tables that have sinks, a water supply, and natural gas and electrical outlets available in sufficient quantity to support a laboratory-based science courses. There is no enough allocation of funds

to provide opportunities to learn in an inquiry-based curriculum. There are no approved guidelines for the safe use, maintenance storage and disposal of laboratory materials.

The findings of the study exposed that the Mathematics Laboratories to the schools were not adequate to meet the growing demand for Mathematics practical. The findings of this study were have also agreed with the findings of Milton and Ohira (2016) who noted that the teaching of mathematics in the schools has not been practical due lack of laboratories. Teaching Mathematics has to be concerned with developing analytical, critical observation and problem-solving abilities as well as the creativity of an individual has to be at play. With the scarcity of the apparatus on the Mathematics Laboratory and their inadequacy, it was very precise that the teaching of science practical though was done, it was not effectively done(Maschietto & Trouche, 2010)

The findings of the study indicated that the Mathematics Laboratory equipment was not of high quality. This was concluded from the respondents against judging the quality of the Mathematics Laboratories available in their schools to be of high quality. However, another non-negligible percentage of respondents did not see any difference between the bad or good aspect of these Laboratories for them to be made the major tool for practical activities in science. The findings are amplified by the MOE (2016) when they indicated that the National Science Centre embarked on the production of Mathematics Laboratories and other low-cost teaching and learning aids and materials and in-service training of teachers. The quality of the Mathematics Laboratories has been designed to move from one classroom to another with convenience in the classrooms and outside but not in rough surfaces. This meant that the quality of the labs was not permanent like the conversional ones. The Laboratories were then designed as a means to introduce practical in the absence of the built ones. This was the more reason they were not very strong

Findings of the study are supported by Vos (2007) who indicates that for effective teaching or learning of science to take place, the learning environment of the pupils must be taken into account which should suit the lesson by organizing the needed equipment on time. He further adds that for effectiveness to occur, the learning also has to be consistent, not only with the Mathematics and Technology Curriculum but also with the various aspects of Mathematics learnt in the classroom. The results meant that the effectiveness of the Mathematics labs could be achieved if the mentioned concerns were sorted out. The math's labs were not effective since they could not provide the needed mobility to the class of Mathematics when needed due to faulty wheels and few apparatuses.

## **5.0 Conclusion**

On the first objective, the study concludes learners taught with mathematics laboratory performed better than those taught without it. The study revealed that laboratory teaching method provides the students with learning experience enriched with in depth examples from environment; students therefore had opportunities to engage in concrete activities that facilitate the development of their performance and retention. This is true, since using mathematics laboratory in teaching mathematics provide opportunity for students to understand and internalize the basic mathematical concepts; which have a holistic advantage of better students' achievements.

On the second objective, the results of the study concludes that the availability of Mathematics Laboratory facilities and their utilization for pedagogical purposes are at low level. This implies that secondary schools in Lusaka district are faced with the challenge of

low availability of mathematics facilities as well as their poor utilization for pedagogical purposes. Findings also revealed that teachers with better qualifications apart from degree were more competent in teaching math's practical using the labs unlike the teachers with lower qualifications. The study revealed that there was lack of awareness of the secondary school teachers on how to employ the math lab and achieve the desired results. Teachers agreed on the importance of the math laboratory and its necessity in the school as the teachers of the school where the laboratory was not available recommended the need to establish the laboratory so that it can be employed and to benefit from its components.

## REFERENCES

- Ado, I., & Nwosu, S. (2016). Influence of Laboratory Method on Students' Mathematical Creativity in Yenagoa Local Government Area of Bayelsa State. *International Journal of Education and Practice*, 4(2), 47-54.
- Ajewole, T. O., Adeyemi, S. B., Amossou, T. E., & Alonge, A. S. (2021). Disposition of Nigerian Secondary School Students to E-Learning Technology during COVID-19 Lockdown. *Journal of Innovation in Psychology, Education and Didactics*, 25(2), 131-142.
- Alshafey, G. A. M., & Aldosary, S. S. (2021). The reality of employing the mathematics lab and its relationship to developing geometrical proof skills among high school students.
- Applefield, J. M., Huber, R., & Moallem, M. (2000). Constructivism in theory and practice: Toward a better understanding. *The High School Journal*, 84(2), 35-53.
- Brandon, A. F., & All, A. C. (2010). Constructivism theory analysis and application to curricula. *Nursing education perspectives*, 31(2), 89-92.
- Carmichael, C. C. (2017). *A state-by-state policy analysis of STEM education for K-12 public schools*. Seton Hall University.
- Cicekci, M. A., & Sadik, F. (2019). Teachers' and Students' Opinions about Students' Attention Problems during the Lesson. *Journal of Education and Learning*, 8(6), 15-30.
- Cockcroft, W. H. (1982). *Mathematics counts*. HM Stationery Office London.
- Creswell, J. W., Fetters, M. D., & Ivankova, N. V. (2004). Designing a mixed methods study in primary care. *The Annals of Family Medicine*, 2(1), 7-12.
- Dewan, H. K. (2016). Building a better mathematics classroom. *Voices of Teachers and Teacher Educators*, 1, 6-18.
- Kunwar, R. (2020). Mathematics laboratory in school level education in Nepal: An overview. *International Journal of Science and Research (IJSR)*, 9(9), 327-334.
- Maschietto, M., & Trouche, L. (2010). Mathematics learning and tools from theoretical, historical and practical points of view: the productive notion of mathematics laboratories. *ZDM*, 42(1), 33-47.
- Matika, V. T. (2015). *An investigation into causes of high failure rate of pupils in Mathematics at O'level at Masvaure Secondary School in Mutare District Manicaland BUSE*].
- Milton, J., & Ohira, T. (2016). *Mathematics as a laboratory tool*. Springer.
- Mushin, I., Gardner, R., & Munro, J. M. (2013). Language matters in demonstrations of understanding in early years mathematics assessment. *Mathematics education research journal*, 25(3), 415-433.
- [Record #27 is using a reference type undefined in this output style.]
- Nyaumwe, L. J. (2011). Developing Mathematics Learners' Problem-Solving Skills through Cooperative Learning. Proceedings of the 19th Annual SAARMSTE Conference,
- Ogunkunle, R. A. (2014). MATHEMATICS TEXTBOOK DEVELOPMENT AND LEARNING UNDER DIFFICULT CIRCUMSTANCES IN SCHOOLS IN NIGERIA. *Development (ICMT-2014)*, 377.
- Okigbo, E. C., & Osuafor, A. M. (2008). Effect of using mathematics laboratory in teaching mathematics on the achievement of mathematics students. *Educational Research and Reviews*, 3(8), 257-261.

- Radovan, M., & Makovec, D. (2015). Relations between students' motivation, and perceptions of the learning environment. *Center for Educational Policy Studies Journal*, 5(2), 115-138.
- Scholnik, M., Kol, S., & Abarbanel, J. (2006). Constructivism in theory and in practice. English teaching forum,
- Singh, P., Teoh, S. H., Cheong, T. H., Rasid, N. S. M., Kor, L. K., & Nasir, N. A. M. (2018). The use of problem-solving heuristics approach in enhancing STEM students development of mathematical thinking. *International Electronic Journal of Mathematics Education*, 13(3), 289-303.
- Ugada, P., Gimba, R., & Abdulrahman, M. (2018). Effects of Mathematics Laboratory Instruction on Students Geometry Achievement and Attitude among Senior Secondary School FCT Municipal Council.
- Vos, P. (2007). Assessment of applied mathematics and modelling: Using a laboratory-like environment. In *Modelling and applications in mathematics education* (pp. 441-448). Springer.

**Comment [L7]:** please pay attention to the writing of references. there are some undefined styles