Problem Based Learning and Students' Academic Achievements in Physics in STEM Model Public Secondary schools in Nairobi Metropolitan Kenya

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Abstract: **The purpose of this evaluation study was to investigate the effectiveness of problem based learning as a stem learning approach in improving student's academic achievements in physics in stem model schools in Nairobi Metropolitan Region, Kenya. The evaluation used the convergent parallel mixed method design of which quantitative paradigm utilized survey design while qualitative used phenomenology approach. The target population comprised of 11principals, 60 teachers and 1120 students while 11 principal, 60 teachers and 297 students were sample size for the study. Proportionate stratified sampling and simple random sampling was used to select students while purposive sampling was used to select teachers of physics and principals. Structured questionnaires, document analysis and interview guide was used to collect data. Descriptive statistics (frequencies and percentages) was used in quantitative data analysis. Qualitative data was analyzed thematically. The study concluded that problem based learning approach is very effective in improving student's academic achievements in physics in STEM model schools in Nairobi Metropolitan region, Kenya. STEM learning approaches like problem based learning: allow physics students to work in groups, discus and share their findings with others to come up with a joint solution to a problem or task , learn through personal experiences, boost confidence among learners, assist in knowledge retention and make students to develop positive attitude towards the teachers and physics as a subject. The study recommends that the government of Kenya through the ministry of education should conduct regular training for science teachers especially the recent graduates and enlighten them in any new and emerging teaching and learning trends. Further, the study recommends that principals should come up with strategies to review school programs and time tables in order to ensure that more time is allocated to science subjects as applying problem based learning requires more than the 40 minutes according to the lessons for Kenyan system. This will ensure that teachers adopt the problem based learning approach while teaching.**

Key Words: **STEM learning approaches, Student's Academic Achievements, Problem Based Learning, Project Based Learning and Inquiry Based Learning**

"Science, Technology, Engineering and Mathematics (STEM) education is a curriculum based on the idea of educating students in four specific disciplines namely science, technology, engineering and mathematics (STEM), in an interdisciplinary and applied approach. To teach STEM subjects, STEM blends the four disciplines into one integrated learning paradigm based on real-world applications, rather than teaching them as separate and independent subjects (Hom, 2014; Rinke; Kinlaw; Gladstone-Brown; & Cappiello;2016). Learning by doing is important in STEM education. The application of STEM by students, with assistance from teachers, "is an innovative approach of turning learning into a hands-on process that is relevant to real life (Centre for Mathematics, Science, and Technology Education in Africa, CEMASTEA, 2018). In this context, interdisciplinary learning means that rigorous academic concepts are combined with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise. This allows for the development of STEM literacy and, with it, the ability to compete in the new economy (Abdalla et al.,2017)". For example, the concept of X-ray in physics is applied in technology in construction of X-ray machines and the same concept is applied in chemistry to understand the concept of radioactivity, and the reactions taking place and mathematics concepts are borrowed in making related mathematical computations.This allows for application of problem based learning in STEM classes. However, Dugger et al (2011) recommends that for effectiveness of integrated STEM program, efforts should be taken in order to choose the best teaching approach that suits these connections in order to realize its goals.

"STEM Education was an initiative created by the National Science Foundation (NSF) with the goal of equipping all students with critical thinking abilities that would enable them to be more creative problem solvers and thus, more marketable in the workforce". STEM education was adopted by the United States in order to address "various issues in the workforce, as evidenced by a significant decline in the number of students pursuing degrees in various STEM disciplines and specific careers", as well as a decline in academic performance in these disciplines (NRC, 2011). Many other countries incorporated STEM model schools with an aim of responding to similar challenges experienced by USA in performance of STEM related subjects.

"In STEM learning activities, soft skills such as problem-solving, higher-order thinking skills, and collaborative work are the main focuses on which students' learning is geared toward (Li; Huang; Jiang, & Chang, 2016; Meyrick, 2011). However, Etkina (2015) argue that preparatory work for each

and every day instruction revolves around an understanding of the physics curriculum, an understanding of what a teacher wants the students to learn in each topic, and the ability of the teacher to identify resources that are compatible with the teaching philosophies" can be quite challenging and necessitates the use of a professional and experienced physics instructor. Enhancing the achievement of students is among the "long-term objectives of any educational institution (Brown, 2012). Studies have shown that STEM education is efficient in enhancing the learning outcomes of students, like academic learning achievement, student motivation, attitude, problem-solving skills (Saraç, 2018; Yildirim, 2016)". However, this has not been the case to some Countries all through years. Some down ward trend in terms of interest and performance of STEM has been observed even when using the STEM learning approaches.

Kennedy and Odell (2014), denotes that STEM approaches are altered from traditional, teacher-centered pedagogies to active, student-centered pedagogies to support student learning. As much as these approaches have positive impact on students achievements, the challenge lies in how the four disciplines can be effectively integrated while at the same time ensuring the integrity of each as these disciplines have their stand-alone scientific principles. Teachers need to be dedicated in using collaborative methods that helps students become partners in learning, that fosters the interest of students and that may offer a remedy to negative attitude that affects student's performance in physics and other STEM related subjects.

Different countries apply a combination of approaches depending on their needs and context (Thibaut, 2018). For instance, Different Approaches to Learning STEM are applied in Thailand to enable students apply the knowledge and understanding of content and develop valuable life skills and relationships in the real world (Asian Development Bank ,2021).The 1st Learning Mode is Deeper Learning that aims to nurture one's inner learning capacity.

In Korea, STEM education is implemented through, presentation of a situation (To let students understand the necessity of problem-solving), creative design (to let students find their own solution) and emotional touch (to encourage students' enthusiasm about solving challenging problems through developing their interest, motivation, and satisfaction of successful problem-solving). (Lee et al. 2013). A report of master card foundation(2019), shows that sub-Saharan Africa use combination of traditional academic approaches blended with constructivist approaches which are; vocationalisation ,interdisciplinary approaches, assessments and integration of local and indigenous system knowledge. In Namibia, pre-vocational approaches are applied at secondary level as it is presumed to enrich curriculum, raise academic standards and increase academic attainments (Tilky et al; 2019). In Kenya, STEM model schools apply project based learning, inquiry based learning and problem based learning.

Problem-based learning is a constructivist, student-centered method of teaching that involves learning through solving unclear but genuine problems (Matthew, 2011). In PBL students learn through engagement in real life problems emulated from likely challenges from everyday life. The PBL process begins with an unstructured problem (open-ended) that the students must solve. The problem may be presented by the teacher or any existing one. After reviewing the problem, students identify information they already know as well as information they need to learn in order to find a solution. The three necessary components are students as the learners, the instructor as a tutor, and the problem as the context (Carrió, Larramona; Baños; and Pérez, 2011). In PBL, student learning centers on a complex problem that does not have a single correct answer. They engage in self-directed learning (SDL) and then apply their new knowledge to the problem and reflect on what they learned and the effectiveness of the strategies employed.

Statement of Problem

Science and mathematics subjects at secondary school level in Kenya are among the high-profile subjects. Since independence, the government of Kenya in collaboration with non-state actors has initiated Innumerable efforts in trying to improve the quality and performance of science and mathematics disciplines in fulfillment of the Kenyan vision 2030 and sustainable development goals (Kenya vision, 2030), Key among them the STEM model school programme (CEMASTEA, 2017). Moreover, Etkina (2015) has argued that physics teachers require adequate knowledge and skill to utilize instructional resources effectively and teachers‟ skills in use of information technology facilitate effective production and sharing of physics content (Berry, 2012). This might lead STEM teacher leaning on the traditional lecture method which might pose a serious challenge in realizing STEM goals.

A baseline survey by the Kenya National Examinations Council (2019) witnessed candidates' alarming failures in science and mathematics in the year 2017. There were very low pass rates recorded in physics, biology and mathematics. Mathematics scored a mean of 32.03 percent, Physics 34.35 percent, Biology 33.5 percent and Chemistry 36.21 percent as compared to languages such as English (57.92 percent), Kiswahili (52.73 percent) and French (63.02 percent). The Kenya National Examinations Council (KNEC) annual reports of the years 2008, 2010 2012 and 2016 have noted that the enrolment in secondary school physics is low with even some schools not offering physics at all. While Murei (2016) and Ng'ang'a (2018) established that peer influence, inadequate infrastructure, poor attitude and poor methods of teaching by subject teachers has contributed to the declining popularity of physics among students leading to low enrolment and low grades at the national level. Kuzhabekova, (2015) denotes that teaching approaches is one possible predictor of utilizing STEM based learning especially the problem based learning methods in the classroom which affects performance . The

pressure to perform and get good grades has resulted to schools turning every opportunity for class work. This pressure has been so much that students have resulted to rote learning and just memorizing facts. Rarely have schools incorporated out of school programme such as robot building and coding, festivals, fairs & exhibitions, excursions, visits to museums to reinforce STEM learning that involve problem based learning. The lack of out of school programs has denied the Kenyan youth important skills that are acquired through hands-on experience (MUSPPA, 2020). This is to say that the current curriculum does not provide appropriate pedagogical approaches required to lay a strong foundation for the development of innovative, creative and other 21st century learning skills considered important for meeting the demand for skilled labour. There are increasing calls for the teaching of STEM within inter-disciplinary settings, as a way of engaging students in authentic tasks and innovation.

Although some studies have shown effectiveness of STEM programme learning approaches in improving student's academic achievement in physics, this is majorly from other countries. The pertinent question at this point is how effective is STEM learning approaches (problem based learning) in improving student's academic achievements in physics in stem model schools in Nairobi Metropolitan Region, Kenya? As such no study has been done in Kenya exploring effectiveness problem learning approaches in improving students' academic achievement in STEM model schools hence this Study sought to fill this gap.

Objective of the Study

The objective of the study was to examine the extent to which problem based learning as a STEM learning approach is effective in improving student's academic achievements in physics in STEM model schools in Nairobi Metropolitan region, Kenya

II. LITERATURE REVIEW

The outcomes-based approach of teaching and learning like that of STEM model program is an effective way of motivating students as it is targeted to accentuate what is learnt by the students instead of what is taught by the teachers. Odell, Kennedy and Stocks (2019) contend that problem-based learning (PBL) positively contributes to student cognitive learning outcomes. At this stage, methods based on problem solving, exploration and research all have great importance for the integration of STEM education (Sahin, Ayar and Adiguzel, 2014). Siregar et al. (2019) posits that the positive impact of STEM programs on student achievement, attitude, interest, and communication skills and problem-solving has come as an awakening call. As a result; the education community has done a paradigm shift on instructional approaches in STEM subjects. This principle is believed to provide benefits for students because they learn more by actively engaging rather than merely listening and focusing on the critical thinking and understanding problems conceptually.

The changes in education systems have caused replacement of common approaches in which students are dependent on books and teachers, and want to get too much knowledge by rote learning, with modern approaches of education (Koray & Koray, 2013). In the 21st century era, students need to be stirred to think critically and innovatively through various meaningful and exciting approach of teaching. A systematic review study by Thibaut, Ceuppens, De Loof, De Meester, Goovaerts, Struyf&Hellinckx (2018) underscored that STEM education in secondary schools uses problem-based learning, and cooperative learning approaches. In contrast to traditional lecture-based learning, which requires students to demonstrate understanding by replicating materials provided by the faculty member on exams (Kuruganti, Needham, & Zundel, 2012), problem based learning has been found to be a better instructional pedagogy to "bridge the gap between theory and practice".

Methods of teaching commonly employed during the training of physics teachers has for a long time been traditional lecture (Cassandra, 2014). Students' have higher gains during instruction when interactive approaches are employed. Methods of teaching particularly in physics should be such that a variety of teaching and learning strategies are incorporated such as tutorials, small group work and experiential learning (Marcelo & Marina, 2014). A meta-analysis study by Taylor et al (2017) was done **as** a follow-up on Promoting positive youth development through school-based social and emotional learning (SEL) interventions in schools in USA.

The study participants were kindergarten to high school students. Follow-up outcomes (collected 6 months to 18 years post-intervention) demonstrated that SEL enhancement of positive youth development. Social-emotional skills, attitudes, and indicators of well-being were high for the experimental than the control group. Benefits were similar regardless of students' race, socioeconomic background, or school location. Borrowing lee from this research, problem based learning approach as a STEM teaching approaches can be enriched with social and emotional learning skills which might result to improved learning outcome. Even though such efforts were seen to produce positive outcomes for student engagement, attachment to school, achievement, attainment, and resilient behavior, it was not on STEM teaching approaches. The current study evaluated the effectiveness of different teaching approaches on student's academic achievements in physics.

Although many studies have shown that problem based learning as a STEM approaches positively improved student achievements, there are still some negative results when integrating STEM activities that are evidenced by James' (2014). His study showed that there were no effects using the STEM approach on the mathematics achievement of seventh graders in central Tennessee. The problem might have emanated from students. As much as teachers try to put measures in place, the final recipient of knowledge and skills is the learner. On the other hand, applying STEM based

approach might be quiet challenging especially if teachers don't have prior knowledge of these approaches. This study was testing the STEM learning approaches on mathematics. There is need to test the effectiveness of problem based learning on other subjects like physics hence the need for the current study.

Problem based approach as a STEM teaching approaches is Learner-centered for they focus on the learners and all activities of the lesson and is planned and executed so as to involve the learner fully. Akinibolola (2010) observes that learner centered teaching gives learners an opportunity to think independently so as to obtain knowledge. Leaner-centered learning according to SMASSE (2005) as observed by Karuri (2011), promotes critical thinking skills such as analysis, synthesis and evaluation. This is affirmed by Gichuhi (2013) who did a study on assessment of learner centred teaching and learning approaches in mathematics and science subjects in secondary schools in Gatundu north district on attitude of students. The study found that students strongly agreed with the statements that they were interested in learning science subjects, enjoyed performing experiments in science subjects, liked to be asked questions, they are interested in group work and that they performed well in mathematics and science subjects.

As much as problem based learning as a STEM learning approaches has a significance influence on students' academic achievements, teachers should actualize this approach appropriately lest they bear a negative outcome. Kahare (2011) indicates that the baseline report of 1999 did in Kenya by CEMASTEA officers; establish that inappropriate teaching methods and approaches were some of the major factors causing dismal performance in mathematics and science. STEM based approaches is a good pedagogy as it sounds, which when well implemented can arouse curiosity to learner which can lead to excellent learning outcome. Instructors need to agree to shift learning to problem based strategies so that learners can take on a more active role in their learning. In all the research studies done in Kenyan context, none of them tested the effectiveness of integrated STEM learning approaches on student's academic achievement in physics, thus the need for the current evaluation study to fill this existing gap.

III. EVALUATION METHODOLOGY

Evaluation Design

This study employed mixed method approach. Specifically, a convergent parallel mixed method design was used. A convergent parallel mixed-methods design is an approach to inquiry that combines both qualitative and quantitative methods concurrently, prioritizing both methods almost equally (Creswell & Clark, 2011: Creswell, 2014). In this case, the quantitative and qualitative methods complement each other, and provide for the triangulation of findings, hence greater validity of the emerging inferences. Whereas the quantitative approach is expected to give more general understanding of the issue of integrated STEM program, the qualitative is expected to provide a detailed and in-depth understanding of the phenomena at hand. Furthermore, DeVaus et al (2014) asserts that qualitative research provides abundant data and creates wider understanding of behavior.

Target Population

The target population consisted of 11 Principals, 110 teachers of physics and who have undergone training on integrated STEM programme and 1100 Form four students who take up physics. The reason for using form four is that they have been taught by STEM trained teachers for a longer period. Form four level marks the end of secondary education where students have already chosen the optional science subjects that are examinable by Kenya national examination council.

Sample Size and Sampling Techniques

The study used both probability and non-probability sampling techniques to draw the sample. Non probability sampling technique refers to a technique where some elements of population have no chance of selection. It involves the selection of elements based on assumptions regarding the population of interest, which forms the criteria for selection. Hence, the selection of elements is non-random (Creswell, 2005). Non probability sampling technique, specifically purposive sampling was used. Stratified sampling was applied for the intention to get the precise representation of the population that is heterogeneous. According to Fraenkel & Wallen (2006), stratified random sampling ensures that particular subgroups or strata are represented at the sample in the fraction that they are existence in the study populace. The required sample of the current study was drawn proportionate to respective populations of respondents. The sample size was 297 students, 60 teachers and 11 principals from the sample schools

Data Collection Instruments and Procedures

The evaluation used both primary and secondary data. The instruments that the researcher used for the study are; questionnaires, Document Analysis Guide (DAG) and interview guide. Before conducting the actual study in the sampled STEM model schools, the evaluator obtained a letter of clearance from the department of Post Graduate Studies in Education, at the Catholic University of Eastern Africa. A permit to collect data was obtained from the National Commission for Science Technology and Innovation (NACOSTI). The evaluator further obtained a warrant from Regional Director of Education, Nairobi office to carry out evaluation in the counties of Nairobi metropolitan Region. On obtaining the permit, the evaluator visited each of the sampled secondary schools to collect data. The questionnaires were administered to students and teachers while interview guide to the principles.

Data Analysis Procedures

Immediately after collecting the quantitative data, the evaluator screened the instrument to ensure it is completely filled out, accurately answered and there is uniformity in interpretation of questions. The data was processed in readiness for analysis. The Statistical Package for Social Sciences (SPSS) version 24.0 was used to analyze quantitative data. The analysis involved descriptive statistics mainly; counts, percentages, frequencies and mean. According to Creswell (2012) and Khan (2014), qualitative data analysis follows systematic procedure which are: data logging (data documentation) which is the next level after data collection, anecdotes (streamlining data log), vignette (narrative or story investigation on the interpretation of the person knowledge or circumstances that the researcher describes), data coding and then tagging the data related according to specific themes. Qualitative Data was organized in emerging trends in line with the evaluation questions used. Drawing ideas from Creswell (2012) the evaluator collected data, organized collected data in emerging trends in line with the evaluation questions, broke data into manageable units, synthesized the units, searched for patterns, displayed in the themes and finally the evaluator drew conclusions

IV. FINDINGS AND DISCUSSIONS

Instrument Return Rate

Questionnaires collected data from teachers and students and interviews from the principals. The questionnaire return rates and interview response are illustrated in Table 1.

Table 1: Instrument Return Rates

	Sample Size	Questionnaires returned	Return rate (%)
Students	297	218	73.4
Teachers	60	39	65.0
Principals	11	9	81.8
Total	**368**	**266**	

Source: Evaluator 2021

From the findings in Table 1, the evaluator distributed 297 questionnaires to students out of which only 218 were returned and this gave a response rate of 73.4%. Moreover, the evaluator distributed 60 questionnaires to students out of which only 39 were returned and this gave a response rate of 65%. Finally, the evaluator targeted 11 principals for interviews but only 9 Out of 11 were interviewed representing a response rate of 81.8% % resulting to a total of 266 participants with a response rate of 72.3%. This was adequate for analysis as per Bryman (2017) who argues that a return rate that is more than 50% is considered to be adequate for statistical analysis.

Problem based Approach and Student's Academic Achievements

The study sought to determine the extent to which problem based as a STEM learning approach is effective in improving student's academic achievements in physics in STEM model schools in Nairobi Metropolitan region, Kenya as per the evaluation question one. The students were asked to indicate the extent to which they agree/disagree that physics classroom teaching and learning effectively use problem-based learning approach, in improving students learning in physics using 1-5 likert scale where 1 is strongly disagree (SD), 2 is disagree (D) (4), 3 is neutral (N), 4 is agree (A) and 5 is strongly agree (SA). This implies that a mean less than 1.5 denotes strongly disagree, 1.5≤Mean<2.5 denotes disagree, 2.5≤Mean<3.5 denotes moderately agree, 3.5≤mean<4.5 denotes agree and mean≥4.5 denotes strongly agree. The findings are shown in Table 2.

Table 2: Students' Responses On Effectiveness Of Problem Based Learning As A Stem Learning Approach

	SD	D	N	A	SA	Mean	StD.
	f (%)	f (%)	f (%)	f (%)	f (%)		
Physics Students are allowed to work in groups, discus and share their findings with others to come up with a joint solution to a problem or task	10 (4.6)	24 (11)	44 (20.2)	71 (32.6)	69 (31.7)	3.76	1.15
We are given chance to do hands-on physics activities and present the findings to students and teachers	12 (5.5)	21 (9.6)	46 (21.1)	66 (30.3)	73 (33.5)	3.77	1.17
Students work individually with the textbook or worksheets to practice newly taught physics content	12 (5.5)	21 (9.6)	47 (21.6)	59 (27.1)	79 (36.2)	3.79	1.19

Source: Evaluator 2022

From the findings regarding use of problem-based learning in learning physics, majority 64.3% of the students agreed that physics students are allowed to work in groups, discus and share their findings with others. The mean for this statement was 3.76. This implies that in most targeted schools' students taking physics are given opportunities to work in groups, discus and also share their findings with others. The findings concur with Sahin, Ayar and Adiguze (2014) who argued that

methods based on problem solving, exploration and research all have great importance for the integration of STEM education.

Moreover, majority 63.8% of the students agreed that they are given chance to do hands-on physics activities and present the findings to students and teachers while 63.3% also agreed that students work individually with the textbook or worksheets to practice newly taught physics content. The means for the statements were 3.77 and 3.79 respectively. These findings imply that students are given chance to do hands-on physics activities and do presentations to students and teachers. There are also cases where students work individually with the textbook to practice newly taught physics content. The findings concur with Siregar et al. (2019) who noted that education community has done a paradigm shift on instructional approaches in STEM subjects. This principle is believed to provide benefits for students because they learn more by actively engaging rather than merely listening and focusing on the critical thinking and understanding problems conceptually

Teachers "were asked to indicate the extent to which they agree/disagree that physics classroom teaching and learning effectively use problem-based learning approach, in improving students learning in physics using 1-5 Likert scale where 1 is strongly disagree (SD), 2 is disagree (D) (4), 3 is neutral (N), 4 is agree (A) and 5 is strongly agree (SA). This implies that a means less than 1.5 denotes strongly disagree, mean scores between 1.5 and 2.5 denotes disagree, mean scores between 2.5 and 3.5 denotes moderately agree, mean scores between 3.5 and 4.5 denotes agree while mean scores greater than 4.5 denotes strongly agree. The findings are shown in Table 3

Table 3: Teacher's Responses on Integrated STEM Learning Approaches

	SD	D	N	A	SA	Mean	StD.
	f (%)	f (%)	f (%)	f (%)	f (%)		
Use of Problem Based Learning in Learning Physics							
I allow my physics students to work in groups, discus and share their findings with others to come up with a joint solution to a problem or task	0 (0)	3 (7.7)	12 (30.8)	15 (38.5)	9 (23.1)	3.77	0.90
I give students chance to do hands-on physics activities and present the findings to me and other students	0 (0)	0 (0)	11 (28.2)	19 (48.7)	9 (23.1)	3.95	0.72
Students work individually with the textbook or worksheets to practice newly taught physics content	0 (0)	6 (15.4)	3 (7.7)	21 (53.8)	9 (23.1)	3.85	0.96

Evaluator :2022

Regarding use of problem-based learning in learning physics, majority 61.6% of the teachers agreed that they allow their physics students to work in groups, discus and share their findings with others "to come up with a joint solution to a problem or task and 71.8% of the students" agreed that they give students chance to do hands-on physics activities and present the findings to me and other students. The standard deviations for the statements were 0.90 and 0.72 respectively and this shows that the data clustered around their mean. In addition, the mean for statements were 3.77 and 3.95. This meant that participating teachers organize the physics students in groups and allow them to discus and share their findings with others to come up with a joint solution to a problem or task. Participating teachers also give students chance to do hands-on physics activities and present the findings to me and other students.

In addition, majority 76.9% of the teachers agreed that "students work individually with the textbook or worksheets to practice newly taught" physics content. The standard deviation for the statement was 0.96 and this shows that the data clustered around their its mean. In addition, the mean was 3.85. This meant that students are allowed work individually with the textbook or worksheets to practice newly taught physics content. Students working individually allow them to develop problem solving skills. The findings concur with Siregar, et al. (2019) posits that the STEM programs encourage students to work individually solving physics problems. This principle might have been the reason to the "increase in the number of students enrolling in physics as it is believed to provide benefits for students because they learn more by actively engaging rather than merely listening and focusing on the critical thinking and understanding problems conceptually".

From the principal interviews on the extent to which teaching approaches used by teachers are effective and how they influence student's academic achievements, nearly all principals said that the stem proponents provide the teaching learning approaches to be enacted. These approaches are "problem-based learning, project-based learning and inquiry-based learning. But teachers still blend it with other methods. Most principals agreed that teaching methods teachers were applying, contributed positively or negatively to the physics grades that the students posted. Some of the influence they mentioned include: boosting confidence among learners,

aiding knowledge retention, makes a student develop a negative or positive attitude towards the teacher and the subject therefore influencing the students' performance either negatively or positively".

In support of the above sentiments one of the principals, P1 said,

> Teaching methods on academic performance are core and their role on students' academic performance cannot be ignored. As I do my lesson observation I anomaly see students happy when applying the STEM learning approach like problem-based learning especially when the teacher is applying it in the right way since the teacher poses a problem to students, they sit in groups, exchange ideas and come up with a solution as the teacher facilitates. It arouses curiosity and motivates students to learn. I think this has partly contributed to students' improvements in students' academic performance. (5th August, 2021).

Moreover, P6 response was:

> You know STEM programme is unique in that it has directed the learning approaches to be applied by teachers. These learning approaches are effective as I can see the number of the student's taking physics in my school has increased. Also, majority of the students post quality grade in physics unlike before. (8thth August, 2021).

From the interviews, the finding was that STEM learning approach like problem-based learning has attracted many students to learn physics. This is because the methods make teaching and learning physics enjoyable for both teachers and students. This tends to have a positive impact on students' enrollment to physics and also their achievements in the subject. The findings deduced from interviews concur with James (2014) who established that STEM approaches positively improved student achievements, even though there are still some negative results when integrating STEM activities. Machaba et al (2016) and Akuma and Callaghan (2019) also revealed in their study that problem solving approaches and inquiry-based learning approaches dominate the teaching of mathematics in South African Schools and are effective in producing positive academic results. Further, the "findings are consistent with Tikly et al. (2018) who argued that effective practice of STEM learning approaches requires a paradigm shift new for teaching and learning process that can address the challenges faced" in delivering STEM content. Preparedness is equally important for any kind of instruction and particularly in STEM. During planning a teacher need to put into consideration the most fitting conduct that will interest learners hence promote learner's mastery of content and not mere cramming of content.

V. CONCLUSION

The study concluded that STEM learning approaches "such as problem-based learning, is very effective in improving student's academic achievements in physics in STEM model schools in Nairobi Metropolitan region, Kenya. Problem based learning approach allows physics students to work in groups and instill problem solving skills among students and enhance innovation and creativity among students.

VI. RECOMMENDATIONS

The study recommends that the government of Kenya through the ministry of education should conduct regular training for science teachers especially the recent graduates and enlighten them on any new and emerging teaching and learning approaches. This will keep the teachers up to date with recent effective stem programme teaching approaches. The training should gear towards helping the teachers become better and more effective in teaching the learners.

In addition, the study recommends that principals should come up with strategies to review school programs and time tables in order to ensure that more time is allocated to science subjects. This will make easy for science teachers to adopt various integrated STEM learning approaches like problem based, project based and inquiry-based learning while teaching.

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