PERCEIVED INFLUENCE OF PARTICIPATION IN NON-FORMAL CURRICULAR ACTIVITIES ON SECONDARY SCHOOL STUDENTS' PERCEPTION AND ACHIEVEMENT IN PHYSICS IN VIHIGA COUNTY OF KENYA

BY

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DECLARATION

DECLARATION BY CANDIDATE

This thesis is my original work and has not been presented for a degree in any other University.

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DEDICATION

This work is dedicated to my parents the late mama Agnetta Imali and Hezron Esitambale for instilling in me a spirit of courage, tolerance, and patience which have enabled me scale up this long academic journey.

Thanks.

ABSTRACT

The school curriculum consists of formal, informal and non-formal dimensions. Formal dimension refers to official timetabled subjects such as Physics. Informal dimension is the school environment that influences a learner's behaviour. Non-formal dimension refers to out of class activities such as field trips and science club activities. The common assumption is that participation in non-formal activities enhances perception and achievement in the formal curriculum. However, secondary schools in Kenya tend to emphasize more on formal curricula and non-formal activities (NFA) are given least emphasis. The contribution of non-formal activities, specifically field trips and science club activities on students' perception and achievement on the formal curriculum had yet to be established. In Vihiga County, participation in non-formal activities has been reported to be as low as 25%, meaning that NFA were neglected and Literature reviewed indicated students' achievement in Physics in the county was low. Physics County mean grade was a D (plain) over the period of 2006 to 2015 and was lower as compared to the national mean grade of C (minus). The purpose of the study was to establish the influence of NFA on secondary school students' perception and achievement in Physics. Objectives of the study were to: establish influence of participation in field trip activities on students' achievement; establish influence of participation in field trip activities on students' perception; establish influence of participation in science club activities on students' achievement and establish influence of participation in science club activities on students' perception. Constructivist theory of learning informed the theoretical framework of the study. The independent variable of the study was scope of participation in NFA and dependent variables were perception and achievement. The study used a descriptive cross-sectional survey and correlational designs. The study population was 1200 Form Four Physics students and 100 teachers of Physics. A sample size of 311 students and 35 Physics teachers was selected from 114 schools through stratified simple random sampling technique. Instruments for data collection were Student Perception Questionnaires (SPQs), Teacher Perception Questionnaires (TPQs), Physics Achievement Test (PAT) and Teacher Interview Schedule. Reliability of the instruments was established through test-retest method and each of the five instruments yielded a value above .7 which was accepted. Validity of the instruments was established through expert judgment by Physics teachers, research supervisors and science education lecturers in Maseno University. Qualitative data was presented by frequencies, percentages, means and standard deviations. Inferential statistics of correlation and independent t-test were used to analyse data. Descriptive data was analysed by use of thematic categories based on objectives of the study. The results showed that participants of NFA had highly significant perception mean scores towards Physics than non-participants. There was no significant difference in Physics achievement means scores for participants and non-participants of NFA. However, perception mean scores and achievement mean scores for field trip activities participants were significantly correlated, as were perception mean scores and achievement mean scores for participants of science club activities. It was concluded that NFA influenced students' perception and achievement in Physics at secondary schools. The findings of this study are useful to teachers, principals, curriculum developers, policy makers, researchers, and book writers for they provide insights on the influence of NFA on students' achievement and perception towards Physics subject. Therefore it is recommended that the Ministry of Education Science and Technology (MoEST) develops policy guidelines for integration of NFA in science subjects at secondary and primary schools. There is need also to establish model science centres in each county to exhibit basic science experiments to learners.

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LIST OF ABBREVIATIONS

CATS	Continuous Assessment Tests
EDES	Emuhaya District Education Statistics Report 2007
HDES	Hamisi District Education Statistics Report 2008
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education
KICD	Kenya Institute of Curriculum Development
KIE	Kenya Institute of Education
KNEC	Kenya National Examinations Council
KSEF	Kenya Science and Engineering Fair
MoEST	Ministry of Education, Science and Technology
SMASSE	Strengthening of Mathematics and Sciences in Secondary Education
WPES	Western Provincial Education Statistics
VDES	Vihiga District Education Statistics Report 2007

LIST OF ACRONYMS

TPQs	Teacher Perception Questionnaires
TPQ2	Teacher Perception Questionnaire Two
TPQ1	Teacher Perception Questionnaire One
TIS	Teacher Interview Schedule
SPQs	Student Perception Questionnaires
SPQ2	Student Perception Questionnaire Two
SPQ1	Student Perception questionnaire One
PAT	Physics Achievement Test
NFA	Non-Formal Activities
JICA	Japan International Co-operation Agency

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Physics plays a critical role in scientific progress as well as technological development in the contemporary society (EU, 2004). Physics equips the youth with basic skills of innovation, creativity and prepares them for their future careers in areas of science and technology. However, many students don't pursue the subject and those whose attempt it fail in national examination. Low performance and poor interest by students in science subjects start at primary and proceed to secondary schools and is more pronounced in Physics subject (Sjoberg & Schreiner, 2005). According to Sjoberg, *et al*. (2005), Physics is difficult and requires innovative teaching methods like field trip activities and science club activities to improve achievement and interest in the subject.

Owolabi (2004) revealed that performance and interest of Nigerian students in Physics at the Ordinary Level was generally poor. Factors cited include lack of laboratories, inability of teachers to explain concepts, no use of active methods like field trips and science clubs activities, lack of textbooks and high enrolment of students in the schools. Namugaya, and Habumugisha (2017) noted that poor performance in Physics by students is due to lack of role models, mentors and teachers who lack subject content. Namugaya, *et al*. (2017), further argued that field trips and science club activities can be used to improve achievement and interest among learners. The researchers recommended use of field trips and science club activities in improving achievement and interest. However, the studies did not look at the influence of the field trip activities on students' perception and achievement in Physics thus the need of this study.

Wambugu and Changeiywo (2008) classified Physics as a difficult, not popular, and avoidable by students, characterized with poor grades and low interest among students in Kenya. The challenges cited include low achievement, methodological issues, and lack of personnel, political, economic and cultural factors (Okere, 2000). The challenges affect delivery of the school curriculum and lead to negative attitudes among learners and hence their poor performance in national examinations. Ndirangu (2003) argued that Physics education in developing countries is viewed as abstract and having remote relationship to technology and engineering. Ndirangu (2003) suggests use of practical teaching methods like field trips, project work, and science club activities to teach the deemed abstract content.

The national performance in Physics lies between 20 per cent and 40 per cent (Wachanga, Changeiywo & Barchok, 2005). This performance is equivalent to grade two (2) and three (3) points out of a twelve-point grading system used by the Kenya National Examination Council (KNEC). Low achievement in Physics is documented in Kenya Certificate of Secondary Education (KCSE) Kenya National Examinations Council reports (KNEC, 2006, 2008, 2010, 2011, 2012, 2013, 2014 & 2017). The reports indicate that the candidates' overall performance in science subjects is low compared to the other subjects of the curriculum. Compared to Biology and Chemistry, Physics subject registers low means nationally as shown in Table 1.

Table 1: Candidates Overall Performance in Physics for the Years 2006 to 2017

Year	Physics	Standard Deviation
2006	80.62	37.00
2007	82.64	35.00
2008	73.42	35.43
2009	62.62	34.02
2010	70.22	35.73
2011	73.28	36.72
2012	75.72	34.58
2013	80.20	38.07
2014	77.68	37.30
2015	87.36	37.58
2016	79.53	42.40
2017	70.09	39.59

Table 1 shows that there are fluctuations in the means scores over the period, however, the general trend indicates a gradual drop in mean score for the period and it has remained below 50% of the total paper score of 200 marks. Further, while selecting subjects for KCSE, Physics is clustered with Biology and Chemistry and students are required to select at least two science subjects (KNEC, 2017). Few students opt for Physics subject and the candidature for period between 2006 and 2017 was below 30% of the total KCSE candidature, while the candidature for other science subjects was in the excess of 80% (Thiong'o, Ndirangu & Okere, 2104). Table 2, shows the number of students who sat for Physics KCSE examination between year 2006 and 2017.

Table 2 KCSE Candidature by subject between 2006 and 2017

Year	Total No. of Students	No. of Physics Students	%	No. of Biology Students	%	No. of Chemistry Students	%
2006	243,453	72,299	29.1	217,675	89.4	236,831	97.3
2007	276,239	83,162	30.1	248,519	89.4	267,719	96.6
2008	305,015	92,648	30.4	271,735	89.1	296,360	97.2
2009	337,404	104,188	30.9	299,302	88.7	328,922	97.5
2010	354,951	109,072	30.7	315,063	88.8	347,378	79.9
2011	409,887	120,070	29.3	363,8171	88.8	403,070	98.3
2013	445,800	119,862	26.9	397,314	89.1	439,941	98.6
2014	482,216	130,752	27.1	430,583	89.3	477,393	99.0
2016	571,654	149,790	38.1	509,982	89.2	566,836	99.1
2017	610,841	160,186	26,2	545,666	89.3	606,518	99.2

Source: Kenya National Examination Council (KNEC), 2017

From Table 2, data for years 2012 and 2015 is missing. However, it is still evident that the total candidature at Kenya Certificate of Secondary Education (KCSE) increased gradually between 2006 and 2017 from 243,463 to 610,841. An increase in candidature is also noted in the three science subjects, however, the candidature in Physics remained at about 30 percent of the total KCSE candidature with exception of the year 2016 which was 38 percent. The low numbers of Physics candidates compared to the other two science subjects signifies the subject is not popular among secondary school students in Kenya hence rises a concern to education stakeholders.

Reasons advanced for low achievement and enrolment in the Physics include students' poor attitude towards Physics, low perception by learners that the subject is abstract and difficult and poor teaching methods used by teachers (Thiong'o, *et al*, 2014). The researchers argued that the challenges can be tackled by use of active teaching methods like field trips, inquiry, science club activities, co-operative teaching as well as use of computer simulation. Since it is noted that students perceive Physics to be abstract and enrolment is low in the subject, consequently, the current study was out to determine whether students' perception of the subject influenced their achievement.

Performance in Physics in Vihiga County is poor, according to Western Provincial Director of Education statistics (2007), Vihiga District Education Statistics (2007), Emuhaya District Education Statistics (2008) and Hamisi District Education statistics (2008). Statistics indicate that students in the county scored mean grade D at KCSE in Physics for the period 2006 to 2105 while Biology had mean of C (plus) and Chemistry had C (minus). Table 3 displays Physics mean scores and grades for Vihiga County from 2006 to 2015.

Table 3: Vihiga County Performance in Physics for the Years 2006 to 2015

	Physics		**Biology**		**Chemistry**	
Year	**Mean**	**Grade**	**Mean**	**Grade**	**Mean**	**Grade**
2006	3.23	D	6.54	C+	4.76	C-
2007	3.50	D+	6.62	C+	5.01	C-
2008	3.03	D	6.73	C+	5.04	C-
2009	3.05	D	6.45	C+	4.53	C-
2010	3.40	D	7.03	C+	4.90	C-
2011	3.35	D	7.21	C+	4.64	C-
2012	3.40	D	5.55	C+	4.85	C-
2013	3.90	D+	6.49	C+	4.72	C-
2014	4.07	D+	6.35	C+	5.35	C-
2015	3.85	D+	5.41	C	4.01	D+

Source: Vihiga County Education Statistics (2015)

Table 3, shows that performance in Physics subject remained at grade D for the entire period except for the years 2007, 2013, 2014 and 2015 which registered grade D (plus). However, the other science subjects maintained almost grade Cs throughout that period. The low grades signify that Physics graduates lack the minimum competency of the subject which stands at D (plus) grade nationwide. A Quality Assurance and Standards report 2011 from Vihiga County (QAS Report, 2011) indicate that participation in field trip activities and science club activities is on the decline and stands at 25 percent of the total secondary school student population compared to 60 percent in previous years. The statistics indicate that the number of students enrolled for Physics at KCSE is on the decline. Poor performance and low enrolment in Physics does not auger well for Kenya which need technologists for sustainable economic development. These observations above provided the impetus to the researcher to investigate whether non-formal Physics curricular activities of field trip and science club activities influenced students' perception and achievement in Physics. .

In a survey, Okere (2000) found that field trips were not being used in teaching Physics in secondary schools in Meru district. Despite the finding, the researcher argued that field trips if used well could enhance students' attitude towards Physics and improve performance in examinations. Okere (2000), asserted that field trip is a powerful tool for building interest among students since they are able to see the relevance of the subject in relation to their future careers.

Literature reviewed generally indicates that field trips activities and other outdoor teaching activities influence students' achievement and interest in Physics and other subjects in the curriculum. The studies encountered are experimental focussing on achievement and interest and mostly originate from the western countries. Furthermore, no study was traced on influence of participation in field trip activities on secondary school students' perception and achievement in Kenya and in particular Vihiga County. In view of this, this study used a descriptive survey and correlational designs to establish whether or not a relationship existed between student participation in field trip activities and students' achievement and perception in Vihiga County.

Science club activities are non-formal activity that influence students' academic performance and interest (Viral, 2016). According to Wikipedia (2015) science clubs are student organizations consisting of administrative structure and functioning with specific objectives. According to Nwankwo and Okoye (2015) science clubs are organizations based in school and are intended to provide students with opportunities to explore science hence improving the science content.

A study by American Institutes for Research (2005), showed that the 225 students involved in science club activities experienced an average 27 per cent gain in Physics scores measured by pre-and post-test scores of an experiment. The researchers noted that the gains in the Physics scores were maintained throughout study which lasted a period of ten weeks. The researcher recommended need for further research on influence of science club activities on students, motivation, interest, perceptions and achievement in other subjects of the school curriculum.

Using a quasi-experiment (Viray, 2016), found that the experimental group exposed to a club activity for teaching vocabulary had higher academic performance and interest than the control group. According to Viray (2016) club activity is an active learning method and students enjoyed the classroom interactions resulting in higher order thinking skills. In a study that examined the extent to which students' participation in literary club activities could predict students' achievement in Literature-in-English (Fakeye, Adebile, Foluke & Eyengho, 2015) revealed a positive correlation/relationship between students' participation in literary club activities and their achievement and interest in Literature-in-English.

The variation in students' achievement in Literature was attributed to the influence of students' participations in literary clubs activities at 77 per cent (R^2 value of 0.77 at $P \leq 0.05$). The study involved two and fifty (250) senior five (5) secondary public and co-educational schools in Ondo State of Nigeria. The study concluded that club activities were relevant to teaching and learning of Literature-in-English and enhanced achievement and perception of students (Fakeye *et al*, 2015).

Nwankwo and Okoye (2015) found that science club activities positively increased secondary schools students' interest in Physics and technology related subjects. The following are the benefits of science clubs activities (Nwankwo & Okoye, 2015); members work on common problems, practice science process skills, develop critical thinking, experience a variety of science topics hence enhanced is their enthusiasm for science and technology. Thus, the need to use ex-post facto design to establish whether science club activities influenced students' perception and achievement in Vihiga County.

In the study, 'Bridging the learning resources gap: an examination of the role of teaching practice projects materials in science education', Ndirangu and Chege (2002), found out that 61% of the students in secondary schools perceived Physics to be boring and irrelevant to their lives. The study attributed the regrettable image of Physics to poor teaching methods used by teachers. The researchers suggested use of science club activities in teaching to improve the students' academic achievement and interest because put ideas and concepts vividly to the learners. The researchers recommended for further research on effects and influence of science club activities on students achievement in Physics and other subjects of the school curriculum hence this study.

According to Kenya Institute of Education (2006), club and society activities are timetabled in the Kenya schools to take place once every week. Club activities help students improve in academic performance, interest as well as develop leadership skills.

However, no literature is available about their influence on students' achievement and perception.

Most studies reviewed have dealt with effects of club activities on student interest and achievement; therefore, this study is set out to investigate influence of science club activities on students' perception and achievement in Physics in Kenya and in particular Vihiga County. This study further applied a quasi-experiment ex-post facto survey adopting a correlational design as opposed to the experimental researches reported.

Science congress activities are a subset of science club activities and is a competition carried out in Kenya secondary school. It is similar to science Olympiads practiced in the developed countries. It is an annual event in school calendar and is facilitated by Department of Quality Assurance and Standards in the Ministry of Education (KIE, 2006). The students present talks based on science concepts, laws, theories and principles focusing on application of science and technology in solving society problems (KSEF, 2018).

Science congress competitions can enable students gain skills of critical thinking, problem solving, creativity, innovation, communication, and collaboration for lifelong learning (Namik *et al*, 2015). According to Gonca (2015) the learning include; acquiring new knowledge within the scope of the competition, expanding academic perspectives, triggering interest in technology, and having positive attitude towards science.

In addition, science congress activities competitions are argued to affect students' interest about the role of science in society, broaden views about contribution of Physics to the society and increase students' interest science. Despite the science club and science congress competition activities being in the school calendar, they influence on students' achievement and perception in Physics had not been investigated. Further, literature available simple assumes that the activities improve learning of Physics without providing concrete evidence. Therefore, this study sought to determine empirically the influence of participation in science congress activities on students' perception and achievement in Physics in Vihiga County of Kenya.

1.2 Statement of the Problem

The Kenyan Government has always emphasized the importance of Physics subject at secondary school, middle level college and university level. This is because Physics knowledge and skills acquired at secondary school level by students are key requirement for admission into science and technology courses offered at high institutions. However, students' performance in Physics national examination has remained poor and students' interest and perceptions towards Physics are low. For instance results for the period 2006 to 2012 indicated a gradual drop of the average national mean score in Physics and it remained below 50 per cent. Similarly, the number of students who sat for Physics between year 2006 and 2011 KCSE was below 30% while the candidature of the other two science subjects were above 80%. This demonstrates low competency as well as poor perception of Physics subject by a majority of graduates at secondary schools in Kenya. Consequently, poor performance in the subject had attracted the attention of many education stakeholders including Ministry of education officials, Kenya National Examination Council (KNEC) as well as other external stakeholders funding education in Kenya.

Numerous studies undertaken have attributed the low performance in the subject to poor teaching methods, unqualified and inexperienced teachers, negative attitude towards the subject by students, perception that the subject is hard, mismatch of the syllabus with its application, and lack of laboratory facilities in schools. For example most students in secondary schools do not see Physics relevant because the subject is taught in a way that does not connect to everyday situations as well as the predominant use of the traditional teaching approach of chalk and talk. Although a number of Physics education researcher had tried to address these factors, what appeared to be least investigated was the contribution or influence of various secondary school non-formal Physics activities on students' perception and achievement in the Kenya secondary school Physics curriculum.

The current study therefore sought to investigate how field trips activities and science club activities influence students' perception and achievement in Physics subject in Vihiga County secondary schools. This was done by comparing students taught Physics through the convectional teaching methods and those exposed to non-formal activities of science club activities and field trip activities.

1.3 Purpose of the Study

The purpose of the study was to establish the influence of students' participation in non-formal curricular activities on their perception and achievement in Physics in secondary schools in Vihiga County

1.4 Objectives of the Study

Objectives of the study were to:

(i) Establish influence of participation in field trip activities on secondary school students' achievement in Physics.

(ii) Establish influence of participation in field trip activities on secondary school students' perception in Physics.

(iii) Establish influence of participation in science club activities on secondary school students' achievement in Physics.

(iv) Establish influence of participation in science club activities on secondary school students' perception in Physics.

1.5 Research Questions

The following questions guided the study:

(i) What is the influence of participation in field trips activities on secondary school students' achievement in Physics?

(ii) What is the influence of participation in field trips activities on secondary school students' perception of Physics?

(iii) What is the influence of participation in science club activities on secondary school students' achievement in Physics?

(iv) What is the influence of participation in science club activities on secondary school students' perception in Physics?

1.6 Significance of the Study

The information generated from this research provides empirical evidence of the learning and teaching associated with non-formal Physics curricular activities in the Kenya secondary school curriculum. It also provides direction on how students can maximally benefit from field trip activities and science club activities. The results also provide secondary school Physics teachers and curriculum developers with a framework for integrating non-formal curricular activities of field trips, constructivist learning approach, inquiry, laboratory activities, project based learning and other related outdoor learning activities in the Physics syllabus.

This study adds significantly to the current literature by establishing how participation in non-formal Physics curricular activities influences perception and achievement in Physics as a subject in secondary school education. The study findings are expected to open areas for further research on other non-formal curricular activities offered in the Kenyan education system.

1.7 Scope of the Study

The study was carried out in the Vihiga County of Kenya and involved 311 students and 35 teachers drawn from 114 secondary schools. The responses of the teachers and students were generalized to the entire student population of Vihiga County. The study focused on the two non-formal Physics curricular activities namely field trip activities and science club activities by analysing the views of Physics students and Physics teacher. Therefore, any other non-formal curricular activities provided by secondary schools were excluded in this study.

1.8 Assumptions of the Study

The underlying assumptions of this study were as follows

i. The study used a survey method to collect data from participants, it was assumed that the participants' answers were truthful, and guarantee of anonymity and confidentiality of all the information they provided. Participation in the study was voluntary and withdrawing from the study was with no ramifications.

ii. The study used as sample of form four students from secondary school from Vihiga County, it was assumed that the sample represented the entire student population in the county. This was assured by getting a representative probability sample from the population based on standard sampling tables.

iii. Lastly, it was assumed that the study instruments addressed the research questions and enabled the researcher answer the questions. This was assured by piloting the instruments in two secondary schools in Vihiga County and the school were excluded from the main study.

1.9 Limitations of the Study

The most notable limitation of this study was use of quasi-experimental design to address the research questions of this study. Aquasi-experiment consists of untreated control group with dependent predictor used to investigate the research questions relating to achievement and perception. Compared to randomized trials, the major weakness of quasi-experiment non-equivalent comparison group design is selection threat to internal validity. Since the groups were not created to be probabilistically similar, it is difficult to know whether observed differences in means scores perception and achievement were due to treatment or some unmeasured difference prior to existing differences between the groups.

This study involved learners in their natural setting and thus it cannot approach true experimental conditions and therefore contains limitations of design that reduced the generalization to a population other than the one studied. The choice of design was an attempt to explain the influence of non-formal activities on student perception and achievement in Physics. This was done through teaching by use of the conventional teaching method and non-formal activities of science club activities and field trip activities.

Within the classroom setting, the methodology of the teacher plays a crucial role in student achievement and perception; however, as Walberg (1984) explains, there are many other factors that affect students' achievement and perception that are beyond the control of the researcher. A teacher's effects go beyond classroom and can interact with teaching methods to influence students' achievement and perception. These effects include teachers' knowledge, experience of teaching Physics, and coverage of syllabus, rapport between teacher and student and classroom management practices.

Any of these teachers' effects can interact with teaching methods to enhance or detract students' achievement and perception.

Another limitation of the study was use of multiple schools from Vihiga County for the research. Although secondary schools in Kenya are provided with a common Physics syllabus for teaching from the Kenya Institute of Curriculum Development (KICD), schools use different textbooks and have different environments for students. These variation in teaching may play a greater role in student achievement and perception which are not accounted for in this study.

Finally, due to limited time and budget constraints, the study was not able to cover a large population of secondary schools and students so as to certain the true picture of the influence of the non-formal curricular activities on Physics learning and teaching.

1.10 Theoretical Framework

Pedagogical, an important aspect of teaching through contexts is the fostering of active construction of knowledge by learners (Fensham, 1996). The constructivist theory of conceptual change for learning underpinned this study. According to Devendra and Prachi (2013) constructivism is a holistic philosophy with the following viewpoints: the need to situate learning and problem solving in real life contexts where environment is very rich in information and there are no right answers; realistic tasks are necessary for meaningful learning and meaning is negotiated through interactions with others.

Devendra *et al.* (2013) still observe that constructivism emphasizes that knowledge acquisition is an adaptive process of the context and results from active cognizing by the individual learner. It believes in the external nature of knowledge and the belief. Devendra, *et.al* further opined that independent reality exists and is knowable to individual knowledge, thus is the results of accurate internalization and reconstruction of external reality. The theory was relevant to the study because non-formal Physics curricular activities of science club and field trip contextualize Physics concepts to real-life situations. Constructivism philosophy, as applied to science classrooms, draws from both the cognitive and social theories of Piaget (1955 and 1972), Vygotsky (1962 and 1978) and Ausabel and Robinson (1969).

This study was grounded on both cognitive and social constructivism philosophies because through non-formal Physics activities students discussed and socialized while learning the relevant concepts. Fundamental to constructivism learning theory is the belief that the learner actively reconstructs old concepts and reviews the new concepts as they are taken in and formed. Moreover, new understanding emerges progressively as the learner develops postulates, test them and re-shapes his/her new understanding on the basis of past and current experience.

The theory sees learning as a dynamic and social process where students bring into the classroom strongly established views of the world, and prior understandings, which are shaped by years of experience. The construction of the new views is as a result of their own personal experiences on interacting with objects or phenomena around them or by being exposed to various sources of media.

Their prior knowledge and conceptual changes will result from the initial held understanding, being challenged and revised by new information. This is achieved through the process of de-constructing and re-constructing of knowledge. The teachers' role is to provide students with opportunities to actively engage in. This ensures teaching is student-centred since it provides opportunities for exploration, discussion, working in groups and problem solving. Hands-on approaches are advocated in constructivist-based learning.

By using environments that incorporate real-life phenomena such as fieldtrips, students are provided with opportunities to review and assess their world-views and be actively involved in the refining of their new understandings in relation to the old learning context. According to Fosnot (2015) and Fensham (2014) (cited in Mwanda, Odundo & Midigo, 2017), a constructivist method of instruction allows learners to interact with the learning environment and challenges, the teacher is to create innovative learning environment for students to think, explore and reflect on their ideas.

Mwanda *et al*. (2017) notes that the classroom teacher guides selection of learning activities to ensure they are challenging but intrinsically motivating to the students. The learning materials focus on bigger ideas rather than facts. Students are encouraged to follow their own interests to reach unique conclusions. Mwanda *et al*. (2017) further suggests a constructivist teacher should provide opportunities to learners to utilize and transfer new ideas to new contexts and as well as allow the learners perform learning tasks within his/her relevant and realistic environment.

According to Braund and Reiss (2006) (cited in Stephen, 2006) are there are seven specific design goals for successful constructivist teaching: to provide experience in the process of making knowledge, to provide multiple perspectives, to infuse learning in authentic contexts, to promote ownership of the learning, to promote social interaction, to exercise multiple modalities, and to encourage metacognition. Arguably, as the learners participate in non-formal Physics curricular activities they develop their social skills as well as improve the knowledge gained in the classroom.

According to Driver (1983) conceptual change refers to the development of fundamentally new concepts, through restructuring of elements of existing concepts, in the course of knowledge acquisition. Therefore, conceptual change is a particularly profound kind of learning that goes beyond revising one's specific beliefs and involves restructuring the same concepts used to formulate those beliefs (Osborne & Freyberg, 1985). In this study, non-formal Physics curricular activities provide multiple phenomena that are central to real application of Physics knowledge. It will challenge students' initial classroom learned concepts which are limited to the textbooks and teachers explanations. The activities not only do they lead to conceptual change, but also allow for evaluation of newer alternatives for learning.

The non-formal Physics curricular activities guide students in the construction of new systems of concepts for understanding Physics phenomena. Still the activities provide opportunities to experience conflict of old and new concepts which in turn enhance conception of Physics scientific phenomena. Devendra *et al*. (2013) note that constructivism maintains that individuals create their own new understanding or knowledge through interactions of previous experiences, ideas, believes, events and activities which they come in contact with. Figure 1 shows relationship between the independent variables, the intervening variables and the dependent variables of the study interrelate.

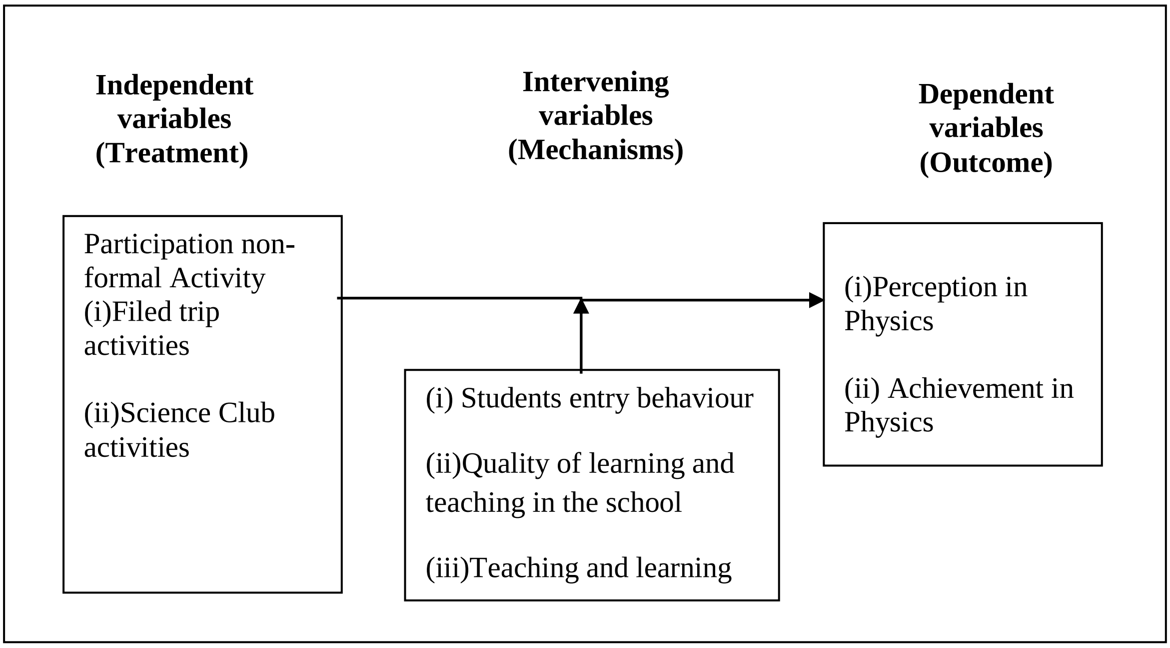

Figure 1: Conceptual Relationship between Students' Participation in Non-Formal Activities and their Achievement and Perception in Physics

As shown in Figure 1, the independent variables or treatment of field trip activities and science club activities which the student were exposed to outside classroom and contribute to students' conceptual understanding, develop students' ability to engage in science inquiry, or increase students' knowledge of key facts and principles. The development of the student cognitive skills may then lead to their improvement in achievement in Physics. On the other hand improved student affective characteristics of interest and motivation may translate to increased perception, demonstrated by student completing assignments at higher rate, as if like the subject and general assimilating of Physics concepts were taught easily.

The intervening variables of this study were: student entry behaviour; quality of teaching and learning in the schools and teaching and learning resources available in the schools. Since the intervening variables could not be manipulated by the researcher during the study, they were assumed to be the same for all the secondary schools sampled. Equally, student abilities were also assumed to be the same or uniform for all students sampled in the study.

1.11 Operational Definition of Terms

For clarity of understanding of the study, the following key terms of the study were defined as follows:

Achievement in Physics: A quantification of student performance on Achievement Test (PAT) to provide a numerical score.

Active learning: It is any instructional method that engages students in the learning process. Active learning requires students to do meaningful learning activities and think about what they are doing (Karamustafaoğlu, 2009)

Constructivism: Learning philosophy that asserts students actively build meaning and understanding of reality through experience and relations, and re-constructing own knowledge consistent with finding or learning theory whereby classroom learning is presented in variety of ways in order to help learners make connections from past knowledge to newly constructed knowledge (Miranda, 2001).

Conventional Method of teaching: The conventional method of teaching or classroom session is used in this research to mean face-to-face meeting scheduled by the school where methods of instruction include all in class teaching and learning strategies. These strategies consist of but not limited to teacher led instructions, student-led instruction, teacher posing questions, student answering questions, student led-discussion, planned student activities, small student–group discussion, large student group discussion, quizzes, test and so on. These conventional teaching method, sessions may be called lectures or lecture sessions within this study.

Field trip Activities: These are activities organized by schools for learners to visit places of academic interest for educational purposes. Students go to places where materials of instruction may be observed and studied directly in their natural setting, for example a trip to a sugar factory to observe cane crushing and sugar processing, a water treatment plant, libraries, museums etc.

Hands-on activities: Generally means learning by experience. Students handle scientific instruments and manipulate the objects they are studying (Rutherford, 1993)

Influence: The capacity or power to have an effect on people character or development or behaviour of someone else.

Laboratory: A special room where learners practise hands-on activities while exploring scientific concepts under the guidance of a teacher.

Learning through Inquiry: Activities that involve the exploration of a task through experiments, reading, discussion, or project work.

Non-formal curricular activities: These are activities allowed outside a formal classroom to supplement teaching and learning process. They boarder on the perception of a learner. For this study activities are science club activities and field trip activities.

Participation: This was taken as student membership and active involvement in field trip activities and science club activities as per school records kept by the head of Physics and science club patrons. The learner involvement or participation in the activities is meant to complement Physics' concepts, laws and principles learned in the classroom.

Perception: Perception refers to the way one thinks about something and ones idea of what it is like. Secondly, it is also an ability to understand the true nature of a subject especially as it effects on our environment. Thirdly, perception is a feeling of curiosity or concern about something and attention the attention it attracts (Akinyemi, 2009). For this study, perception is a cumulative mean score obtained from students' perception questionnaires indicating that the student's liking for a particular science activity of science club activities and field trips. Perception towards the non-formal activities of Physics in this study was categorised as either high, moderate or low Perception.

Project-Based learning: An authentic learner-centred task that require students to convey their learning through models.

Science Club Activities: School Club Activities timetabled to take place after classes from 4.00 pm and once every week in secondary schools in Kenya. Science Congress Activities a subsection of Science club activities is an annual competition organised for Kenya secondary students and requires learners to come up with innovations addressing societal problems and is directed and coordinated by the Department of Quality Assurance and Standards in the Ministry of Education, Kenya. Student perception was considered high if their mean score was between 3.5 and 5.0, moderate if their mean score was between 2.5 and 3.4 and low if their mean score fell between 1.0 and 2.4. Teacher perception towards non-formal activity was the total score from teacher perception and converted to percentage. Perception is an important attribute in a school context since it can influence students' levels of learning, academic performance and the quality of learning experience (Hidi and Renninger, 2006).

CHAPTER TWO

LITERATURE REVIEW

2.1 Influence of Participation in Field Trips on Students' Achievement in Physics

Physics curricular consist of formal curricular, non-formal curricular and informal curricular (Aykut & Necati, 2009). Formal curricular is pre-planned, class and school-based, has specific aims and objectives (Ainsworth & Sarah, 2010; Aykut & Necati, 2009). The formal curricular is emphasized in Kenya schools and has a prescribed syllabus, textbooks and learning objectives (Kenya Secondary Syllabus, 2006). It is timetabled and is evaluated through formative and summative evaluations. Informal curricular is unstructured and learning is done individually and learning outcomes are hardly evaluated (Marsick, Volpe & Watkins, 1999).

Non-formal curricular activities are not classroom or institution-based and are less structured (Wellington, 1990). Non-formal curricular is less emphasized in Kenya secondary schools yet is timetabled after class. The activities are implemented outside the classroom main timetable and learners choose the activities based on their interest. The activities give students the opportunity to make connections with real objects and improves their comprehension and retention of knowledge as well as providing new perspectives, attitudes and values (Aykut & Necati, 2009).

A field trip activity is defined as an instructional trip, school excursion or school journey with educational intent in which students interact with surrounding, displays, and exhibits to gain a realistic connection of ideas and concepts learned in the classroom (Krepel & Duvall, 1981). Tal and Morag (2009) describe field trips as student experiences outside of the classroom and designed for educational purpose. Behrendt, *et al*. (2014) observes that field trips taken by students are unique and cannot be duplicated in the classroom and enable each student to observe natural setting that creates relevant learning experience.

According to Ajaja (2010), field trip is an outdoor or field work or learning exercise undertaken by teachers and students in certain aspect of subject so as to give the students an opportunity to acquire knowledge. Krepel and Duvall (1981) notes that field trip are arranged by schools and undertaken for educational purpose in which students go to places where materials of instructional value may be observed and studied directly in their functional setting.

Field trips require students to travel to off-school venues and these include museums, industries, hospitals, research centres, construction sites, power stations and airports. The success of field trips depends on how well they are planned. Each phase and its development should be anticipated and appropriate alternatives put in place, for inadequate planning may result in unworthy while activities. Behrendt *et al.* (2014) further noted that interactive exhibits help students play with concepts and activities often not found in the classroom.

Behnendt and Frankline (2014) and Okere (1996) observe, a fruitful field trip is realized if it has concrete connections to classroom curricular and students are given background information about the place to be visited in advance and the relevant topics have been covered in class. After the field trip, it is imperative that the teacher spends sufficient and quality time to reflect on the experiences and help students' build connections to the school syllabus concepts (Behnendt & Frankline, 2014).

In support of this, Lei (2010) observes, prior course content becomes relevant to students as they assimilate and accommodate new understanding and cognition from any non-formal setting. In a study that investigated the effects of field trips on students' achievement and motivation in Physics education, Stephen (2006), found that after one semester with seven field trips experiences the general population of students experienced a significant seven percent increase in achievement from the pre-test to post-test results. The reason why field trips increased students' achievement is that students are able to observe the real nature and application of science (Braund & Reiss, 2006). The researcher suggested for further investigation on the effects of field trip activities on students' achievement, interest, perception and motivation. Therefore, this study will further investigate the influence of field trip activities students' achievement in Physics in Vihiga County.

Much of the literature on field trips originates from visits of museums, science centers, zoos, aquariums, planetariums, field work and nature centers (Machine, 1998). The studies are concerned more about the promotion of the use of the museum as a strategy of learning and teaching, opinion of teachers on the use of field trip method, students' achievement and attitudes in relation to field trips and museum learning. Other studies have looked at reasons for taking students for field trips in relationship to providing first-hand experience, stimulating interest and motivation in science, observation skills and social development for students. However, no literature has been located in Kenya on influence of field trip activities on students' achievement in Physics thus the need to undertake this current study.

Stephen (2006) extols that it is embarrassing for a teacher to arrive at site with an eager group of students and find out no one expecting them. Other pitfalls encountered during field trips are giving the students too much work until they miss on the experiences and over estimating the number of students going on the trip for that might not be in line with the requirement of the place being visited (Stephen, 2006). Stephen (2006) further notes that an effective field trip should put the following in consideration: pre-visit the intended location, find if the site has what students are to observe, plan a date and communicate the number of students and their ages to the site in advance.

A study in Western Australia by Rahman and Spafford (2009), revealed that biology field trip boost students' academic performance and interest. According to Rahman, *et al*. (2009) field trip and fieldwork impact positively on student long-term memory due to their memorable activities. Researchers argued that field trips assist in developing problem solving skills, social relationships and hands-on skills; though, teachers in the study disagreed that the activities are helpful in selecting careers.

In a study to determine if students' participation in field trips influenced knowledge of science process skills and interest in Biology, (Ajaja, 2010), found a significant difference between the knowledge of participants and non-participants of field trips. The results indicated that science process skills scores for participants of field trips on pre-test and post-test were high than that of non-participants. The study concluded that field trips enhanced students' understanding of science process skills, improved students' interest towards biology and improved achievement.

Ajaja (2010) further argued that field trips provide opportunities for meeting organism in their environment, enabled students gain new insights, and allowed students to touch and feel real specimens. Further, field trips facilitated processing of biology concepts and principles using all the senses hence higher retention of knowledge. The researcher recommend for future research on the effects of field trip activities on students' perception using other subjects of the school syllabus. However, this study sought to fill the gap of knowledge by determining whether non-formal Physics curricular activities influenced students' perception of Physics by using a quasi-experimental and ex-post facto survey design.

Adeyemo (2010) looked at the relationship between students' participation in school based field trips and their achievement in Physics in Lagos State of Nigeria. He analysed data from a survey of two hundred students of senior secondary III Physics students. Result showed that participating in field trips influenced students' achievement in Physics and that student's non-participation in the activities lead to poor academic achievement. Past research has indicated that there exists a significant relationship between field trips activities and academic performance.

Physics education in Kenya is plagued with many problems; top on the list is dismal performance by learners in national examination despite all efforts by teachers, education officers and other stakeholders in education. According to Njoroge, Changeiywo and Ndirangu (2014) the overall students' performance in Physics at Kenya Certificate of Secondary Education (KCSE) is poor coupled with low student enrolment. Njoroge *et al.* *(*2014) attributed this to sorrow state to use of expository teaching methods which are ineffective in inculcating content knowledge, conceptual knowledge and science process skills that make up quality Physics teaching.

Reacting to 1999 performance in Kenya Certificate of Secondary Education (KCSE), Ndirangu (2003) argued that secondary schools graduates showed little mastery of the Physics subject. During the year, performance in Physics and Chemistry was at 29 per cent and 28 per cent respectively. This indicated that students were ill prepared to operate in a rapidly changing society stimulated by the advances in science and technology.

Poor performance in examinations was attributed to ineffective teaching methods which encouraged memorization of facts geared towards passing of examination. According to Ayieyo, Mnag'are, Ngome and Mandialah (2015) dismal performance in Mathematics and science subjects in Vihiga county can be attributed to the following factors poor pedagogical approaches, low interest among most learners and low mastery of subject matter by teachers. This clearly signifies low achievement and interest in Mathematics and Physics among students in Vihiga County.

Dismal performance in mathematics and science subjects in the past prompted the Government of Kenya through the Ministry of Education Science and Technology (MoEST) to start a programme for Strengthening of Mathematics and Science in Secondary School Education (SMASSE) with support of Japan International Co-operation Agency (JICA). The programme focuses on improving teaching methods skills and encourages teaching through hands-on activities such as field trips, project work and science club activities and science competitions (Changeiywo, 2000).

In a study that investigated the use of improvised teaching material by teacher trainees Ndirangu and Chege (2002) found that secondary school students in Kenya displayed regrettable negative attitudes towards science subjects. Students perceived the subjects as difficult and strenuous to learn because they were taught through chalk and talk methods. Other problems facing teaching of science subjects in Kenya include, lack of text books, misconceptions, language; lack of teachers, conflict between African culture and the scientific method and difficult subject content (Okere & Keraro, 2002). Njoroge, Changeiywo and Ndirangu (2014) and Okere and Keraro (2002) suggest that one approach that could improve science curricular in secondary schools is to utilize non-formal activities of field trips, science club and science congress activities.

According to Okere (1996), what is learned in school is not perceived to be useful by learners immediately. This is a challenge many teachers face while teaching science to students. Okere (1996) argued that use of non-formal Physics curricular activities such as science field trips, project work and science club activities for teaching. Okere (1996) observes that through field trips students observe real application of Physics in life.

Based on researches reviewed, field trip activities stimulate new learning, improve attitude towards science, trigger interest, and provide multiple channels for teaching and learning. However, there is little evidence that empirical studies on influence of field trip activities on students' academic achievement in Physics have been undertaken in Kenya and in particular Vihiga County. It is with this background that study on the influence of participation in field trip activities on students' perception and achievement in Physics in Vihiga County was conceptualised. As opposed to true experimental designs and interview reported in the literature, this study will employ, quasi-experimental design and ex-post facto survey design to fill the knowledge gap.

2.2 Influence of Participation in Field Trips on Students' Perception of Physics

According to Tanel and Erol, convectional classroom teaching strategies hardly improve the teaching of Physics abstract concepts. Most of the teaching methods applied in Kenya classrooms are teacher-centered and hardly give students adequate opportunities to actively participate in teaching and learning (Kiboss, 2000; Tanui, 2003). Kiboss (2000), argued that expository teaching approach is the dominant teaching method commonly used in Kenya schools. It is therefore necessary to use methods which utilize instructional activities in which students get involved in doing and observing the application of what they are learning. It is against this background that this study attempted to investigate the influence field trip activities on students' perception on Physics.

Field trip activity is a non-formal method of teaching and entails students and teachers visiting both near and far sites of interest around their schools. Learners can visit manufacturing industries, production plants, show grounds, research stations and assembling plants, hospitals, power stations and airports. The visits enable students to see real applications of classroom science thus motivating them to study hard and join the observed fields (Morag, 2006).

Holland and Andre (1987) in a review of studies on non-formal curricular activities in American education indicated that the activities improved students' interest, perceptions and academic performance. The paper also indicated that academic grades in males and interest for all students improved when they participated in non-formal curricular activities. Behnendt, *et al.* (2014) in a review of researches on school field trips and their value in education noted that the activities are tools to connect students to classroom concepts and greatly increased their interest towards Physics.

The researcher further observed that field trips venues provide experiential learning which increases student subject knowledge, perceptions, interest and motivation. Linda (1997) notes that often overlooked in science instructional process is the non-formal science learning environment which provides captivating science experience which relate closely to the curriculum objectives. According to Whitesell (2015) students' educational outcomes are influenced by many different factors such as resources, size of class, teacher quality, and family characteristics and neighbourhoods' factors.

Physics teaching and learning is multi-dimensional in nature and can take place both inside the classroom and outdoors. Studies from around the world for the last fifty years indicate that Physics teaching and learning can effectively take place in field trips, zoos, science club activities, science museums and other informal settings (Davidson, Passmore & Anderson, 2010; Nielsen, Nashon & Anderson, 2009). Aykut *et al.* (2009) notes this dimension supports formal curricular by enabling many people enjoy, acquire and understand new information arising from rapid technological developments.

Non-formal meets the needs of students by addressing learner different learning styles and allowing them to learn at their own pace (Melber & Abraham, 1991). Examples of non-formal learning environments cited include sporting activities, games, playing musical instruments, television, radio, newspapers, magazines, science centres, outdoor laboratories, aquariums, forests, technology parks, botanic parks, internet, field trips, and visits to show grounds, participating in science club and debating (Aykut & Necati, 2009). According to Heather *et al.* (2010) non-formal dimension may not be intentional or arranged by an institution but is usually organized loosely. There are no grades or credits granted for non-formal learning activities by institutions.

Dilon *et al*. (2006) in a review of 150 studies from 1993 to 2003 found substantial evidence that field trips properly conceived, adequately planned, well taught and effectively followed up, offers learners opportunities to improve their interest, perceptions, knowledge and skills in ways that add value to their everyday experiences in the classroom and their future careers as well. Other studies have indicated that field trips boosts students' confidence, interest and perceptions in learning the Physics subject matter and helped improve social skills (Anderson *et al*., 2006).

Research also shows that students are much more confident in meeting academic challenges as a result of participating in Physics field trips (Boyle *et al.,* 2003). Anderson *et al*. (2006) further noted that field trips can have a positive impact on long-term memory due to the memorable nature of the fieldwork setting; it can reinforce student's interest, perceptions and cognitive domain as well as provide a bridge to higher order learning. Related studies on impact of field trip activities on student's learning and interest reveal that the role of the teacher in pre-field and post-field trip activities have the potential to enhance student learning (Anderson, 1999; Anderson, 2006).

In Pakistan, Bashir and Hussain (2012) found that participants of field trips in secondary schools had higher academic achievement than non-participants of the activities. The study involved 200 students in Islamabad-Pakistan who were divided into experimental group and control group. Bashir *et al.* (2012) concluded that participation in field trips and club activities enhanced academic achievements for government and private schools as well as for boys and girls.

In a study that investigated the teaching experience of pre-and in-service teachers on use of field trips in teaching in Israel, instructors and teachers found that support, collaboration and careful preparation of learning activities yielded positive outdoor teaching experience of performance, interest and perceptions (Morag, 2006). This only happened if teachers made immediate follow up of the learned activities during the field trip. However, the study highlighted that the teachers faced challenges such as lack of confidence, class management and inadequate student motivation.

Before the actual visit field trip, Behrendt and Franklin (2015) suggest that teacher should visit the venue prior to the field trip, learn about the layout of the venue and determine whether the venue are suitable for the students learning. During the orientation, teachers should prepare students by describing the venues and their layout as well as make the students understand the focus or purposes of the field trip experience.

KIE (2006) notes that field trips help learners to develop interest, motivation, improve academic achievement and stimulate an appreciation of the importance of science. Further, the handbook states that field trips improve students' skills of observation as well as assist in developing interest in particular careers observed in the field. For effective management of field trips, the KIE (2006) handbook notes that proper co-ordination should be put in place with a view of minimizing disruption in the school programs.

Despite the high cost, time and hassles teachers go through they should be encouraged to use the field trip activities in teaching. Other advantages of field trips in science education include promotion of opportunities for new experience and application of science in daily life, stimulate interest and perception of students, integrate school activities with community life and stimulate students' participation in discussion of the activities learnt in the field trips (Okere, 1996; Stephen, 2006). From the literature reviewed, there is evidence that field trip activities influence students' interest, motivation, attitude and perception in learning subject content, however, little is documented about the influence of field trip activities on students' perception in Vihiga County and Kenya as a whole hence need of this study to address the gap.

2.3 Influence of Participation in Science Club Activities and Achievement in Physics

Kenya is currently craving for sustainable development through science and technology, however, a majority of students in schools perform poorly in Physics subjects. Robelen (2011) notes that Science, Technology, Engineering and Mathematics (STEM) clubs programs have gained prominence in education because of their potential to promote students' achievement in Physics subject. A pedagogical strategy proposed to improve achievement in Physics subject is getting students to belong and actively participate in science club activities like Junior Engineer, Science Jets and Rocket Science (Duyilemi & Oluwatelure, 2012). Science club activities allow students to explore Physics concepts not covered in the school classroom.

In a study conducted in Nigeria, Nwankwo and Okoye (2015) found that science club activities positively improved secondary schools students' academic achievement in science related subjects like Physics, Biology and Chemistry. National Research Council NRC (2009) observes that science club activities can positively influence student academic achievement since they make the students enthusiastic to learn science.

According to Kenya Institute of Education (2006), club and society activities are timetabled in the Kenya schools to take places after classes once every week. They are a vital component of the school science curricular because students use them to improve their academic achievement. Clubs are headed by teacher patrons appointed by school headmasters. Students in respective clubs elect their leaders who are mandated to organize and run the clubs for a period of a year. Mathematics and science clubs are most popular clubs in the Kenya secondary schools and attract science oriented students who aspire to pursue careers in scientific fields like engineering, medicine and research.

In a study by Rabari *et al*. (2011), found that schools that provide conducive environment of out-of-class activities enhanced student creativity. The out of class activities cited in the study included science club activities and school-based science competitions used to select participants of science congress. The students interviewed in the study observed that the science club activities inspired them to make scientific innovation, contribute to technological development of the country and satisfied their personal curiosity.

The following are the general benefits of science clubs activities to students (Nwankwo & Okoye, 2015): members come together to find solutions to common problems; practice science process skill; develop and practice critical thinking; experience wider range of science topics hence develop higher enthusiasm for science; practice science and technology skills; build skills to analyze and solve scientific and technology problems and develop skills for design and investigation of identified problem. Much of the literature reviewed only mention the usefulness of science club activities on student learning. However, no specific studies have been identified in Kenya on the influence of participation science club activities on students' achievement in Physics. Therefore the aim of this study was to carry out an empirical research on the influence of participation in science club activities on students' achievement in Physics in Vihiga county of Kenya and fill the knowledge gap.

2.4 Influence of Participation in Science Club Activities on Students' Perception of Physics

The perceived irrelevance of Physics curriculum is seen as one reason for adolescents' low achievement, low interest and lack of motivation to pursue Physics in higher education (Sjoberg & Schreiner, 2005). Decline in achievement and interest in Physics subject has led to closure of Physics departments at universities in New Zealand (Buabeng, Conner & Winter, 2015). According Buabeng *et al.* (2015), the decline in numbers of students taking Physics could be due to a combination of factors including the perception that Physics is a hard subject, low levels of student achievement the perceived nature of the subject as being highly Mathematical and abstract and how it is taught at high school level.

Buabeng *et al.*(2015) interviewed Physics teachers in their study and found out that the teachers believed several factors hindered the quality of teaching and learning of Physics in New Zealand high schools and that the factors contributed to declining student interest and perception in the subject. Chief among the limiting factors cited were assessment demands; curriculum and time-tabling, limited access to Physics teaching at junior science level, teacher factors and pedagogy, the perceived nature of Physics, low salary, lack of incentives for teachers to enter the profession and poor student Mathematical literacy. Many teachers in the study believed that Physics teaching in New Zealand is driven by assessment, not by student interest and the schools placed too much emphasis on performance and grades. The researchers recommend use of field trips, science club activities and science competition among other things to address the challenges.

Brown and Atkins (1997) argue that bad teaching reduces learner interest and promotes poor attitude towards Physics resulting in low performance in the subject. National Research Council NRC (2009) concurs by noting that science technology engineering and mathematics (STEM) clubs can stimulate science interest among children since they encourage learners to see that Physics is relevant. Zietsman and Naidoo (1997) observe that understanding of Physics concepts improves when what is taught to learners was anchored in science club activities.

A study conducted in Kenya on students' interest in Physics showed that most learners have low interest in the subject. The study, "Bridging the learning resources gap: an examination of the role of teaching practice projects materials in science education", Ndirangu and Chege (2002), found out that 61% of the students in secondary schools perceived Physics to be boring and irrelevant. The study attributed the regrettable image of Physics to poor teaching methods used by teachers. The researchers observed that to improve student interest in

Physics there is need for students to join science club activities which encouraged collaboration, peer teaching and open discussion among the students.

To deepen Physics education provided in the classroom, students need to participate in activities done outside the classroom environments so as to improve in performance as well as see the real applications of science and technology. Hofstein and Lunetta (2003) claimed that there was failure in science education to examine the effects of various school science experiences on students' attitudes. The two researchers argued that investigating the influence of experiences on adolescents' attitudes would be important for science education, since the experiences promote positive attitudes which could be beneficial to students' interest and academic achievement.

Based on Hofstein, *et al*. (2003) claim that there is failure in science education to examine effects of various science experience. The aforementioned challenge is replicated in Kenya based on literature reviewed. As such, a study of influence of participation in science club activities on students' perception in Physics was conceived.

To enrich this study, the influence of participation in science congress activity a subset of science club was evaluated. Science congress competition is an annual event in secondary school calendar and is directed by the Department of Quality Assurance and Standards in the Ministry of Education (KIE, 2006). Science congress activities start at school level and winners proceed to sub-county, county and regional and then finally to national science congress competition.

Student present talks and exhibits in the areas of Mathematics, Physics, Chemistry, Biology, Home science, Technical subjects, and Agriculture (KIE, 2006). Mathematics and science clubs are some of the most popular clubs in the Kenya secondary schools and generally attract science oriented students who aspire to pursue careers in science engineering and technology. The student's presentations are based on science concepts, laws, theories and principles learned in classroom and focus on application of science and technology in solving society problems.

The competitions are judged by teachers at school, sub county and regional levels, however, at national level judges are drawn from the industry and universities. Some of the projects presented in previous science congress competitions include: automated multi-story irrigation system; automatic water switch, homemade water recycler, ammonia fertilizer from Sodom apple and bird feathers, mosquito repellent from cypress and cow dug, formula for balancing chemical equations, making soft board from water hyacinth; computerized fishing system; fireless charcoal balls from cow dug and mud, a number line using logarithms, "anthosa" detector-chicken feeding system applying moments of forces, solving surd using logarithms and making briquettes from saw dust and waste paper (KSEF, 2017).

According to Gonca (2015) there are differences between Science festivals, Science Olympiad and Science Fairs, though both contribute to students' achievement is science subjects. Science Festivals are global phenomena which include small, localized events reaching small groups up to nationwide events targeting millions of participants (Bultitude *et al*, 2011). Science festivals on the other hand are events that include fairs, exhibitions, science shows, and demonstrations, stage shows, street presentations, workshops, outdoor activities, interviews that reflect the integration of science and technology and enable dissemination of scientific knowledge.

Finally, science fairs are events in which participants share their research findings and innovation with parents, friends, teachers, scientists and the general public and are generally smaller than science festivals. Although, science festivals, science Olympiad and science fairs that taken different forms around the world, they have the same general aims as follows: they contribute to creation of creative ideas by arousing scientific curiosity in human beings, allow people to base their everyday arguments on scientific facts, contribute to positive development of participants' knowledge and scientific studies within various application (Gonca, 2015).

Research indicates that student engagement in science competitions in their early years enhances their interest in the science subject and in particular Physics which is perceived as difficult by many learners (Sahin, 2013). According to Behrendt and Franklin (2014) Olympiad or science competition is a form of non-formal activity and is an effective method to develop students' perception in Physics since it creates authentic opportunities for students to learn regardless of the content area. Researchers note that a strengthened perception in science may easily lead students into science related career paths or establish higher quality scientific literacy. In addition researchers observe that science competitions or Olympiads offer a unique opportunity for students to create connections which help them to understand, develop and enjoy learning.

Further, during science competitions students sharpen their skills of observation, thinking and perception since they utilize fully their five senses. As a result they are likely to develop positive attitudes to learning, motivating them to visualize connections between the theoretical concepts learned in classrooms and what they are exposed to. Behrendt and Franklin (2014) still note that outdoor activities especially science competitions and field trips provide opportunities for students to develop increased perception, greater vocabulary and increased interest in surrounding environment.

Finally, researchers argue that developed perception stimulates curiosity, empowering students to ask questions, discuss observation, consider past experience. This is because the outdoor activities encouraged hands-on learning and group learning and created a platform to develop positive attitudes and perception towards subject. Other studies have indicated that science competitions boost students' confidence in learning the subject matter and help improve perception (Anderson *et al*., 2006).

Research also shows that students are much more confident in meeting academic challenges as a result of participating in science competitions (Boyle *et al*., 2003). Zietsman and Naidoo (1997) concur on this finding by providing research findings indicating that understanding of Physics concepts improved when what is taught to learners was related to science competitions.

A study by Waswa (2017), investigated the influence of school-community relationship on students' academic performance and established that communication skills influence teaching and learning which when harnessed improved interest and academic performance. The study adopted a mixed methods' approach and a descriptive survey design with a sample size of 782 respondents. Data was collected using Likert scale questionnaire and interview schedule. It was analysed using descriptive statistics of frequencies, percentages, means, and standard deviations. Qualitative data was analysed by describing emerging content from the respondents in relationship with the study objectives.

Science congress activities can easily affect students' interest about the role of science in society, broaden their views about contribution of Physics to society and also increase students' interest about scientists. However, despite the activity being an annual event in the Kenyan secondary school calendar and has been argued to be assisting students to learn Physics, the influence of the activities on students' perception of Physics in Kenya secondary school has not been documented, thus the need of this study.

Ajaja (2010) observes that the following could assist teachers in planning effective field trips: develop field trip objectives in consultation with students; outline to the students where they are going, why they are going and what they expect; make prior visit to the site and obtain any advance information to give the students as well as obtain the relevant permission. Ajaja (2010) and Okere (1996) agree that the following should be considered by teachers in advance: discuss trip with head teacher and obtain approval and finances; obtain the consent of parents and guardians, and also from teachers whose lessons will be taken over by the trips; prepare student questionnaires and share out trip roles among students and discuss behaviour standards with students.

Finally prepare for transport, feeding and accommodation without forgetting emergency issues. Despite the educational value attached to non-formal activities, teachers rarely use them in teaching students. There are several reasons advanced for no use of this research proven strategies in teaching in schools. According to Behrendt and Franklin (2014), science teacher education programs do not instruct pre-service and in-service teachers on how to conduct and co-ordinate field trips. The two researchers noted that well trained teachers will conduct successful field trips and assist students to develop perception in science, which may lead to improved learning.

Another impediment noted by the researchers is that school systems limit science field trips and recommend use of alternative inexpensive or cost-free field trips. These include visiting a local market, farms, industry or even a visit to workshop. Sarker and Frazier (2008) found that reasons for teachers' no-use of the strategy included: lack of knowledge on how to integrate the activities into classroom curricular, teachers being unfamiliar with local resources available, lack of time to organize the activities and failure on the part of schools to allow field trips hence scheduling difficulties.

Other common factors why field trips are rarely used are: the high financial costs involved in the activities and the fact that they are not examined in national examinations and the teachers' inability to manage groups of students outside the school (Stephen, 2006). Negative aspects associated with non-formal Physics learning activities are that they foster misconceptions and that students' interest rise mainly from entertainment received at the sites of visit (Braund & Resis, 2006).

Sarkar and Frazier (2008) have outlined specific strategies for overcoming the aforementioned factors of engaging students in field trips and other non-formal activities. The strategies include: narrowing the scope of activities by participating in locally based project or those of shorter length, establishing non-formal Physics activities guidelines, soliciting help from parents, starting with a field trip on your school compounds, dividing long projects into manageable daily activities and having students make concept maps to connect their non-formal Physics activities to classroom learning. Studies on negative aspects of field trips in perspective of western countries realized the following difficulties with transportation, high cost of field trips, long time consumed in considerations for preparation and fitting the activities in the school timetable, lack of support from school administrations for field trips, curricular inflexibility, poor student behaviour and inadequacy for field trip venues (Machie, 1998).

According Morag (2006) this happened if teachers made immediate follow up of the learned activities during the field trip. However, the study highlighted that the teachers faced challenges such as lack of confidence, class management and inadequate student motivation. Dilon *et al*. (2006) noted several factors that influence field trip learning. These are (1) fear and concern about health and safety of students, (2) teachers lack confidence in teaching outdoor, (3) curriculum that are formal and do not have activities, (4) shortage of time, limited resources and inasufficient support from administrators and (5) frequent changes within the education curriculum. In a review of articles on school fieldtrips and their value in education, Behrendt and Franklin (2014) noted that fieldtrips and other non-formal curriculum activities offer opportunity to connect students to classroom learnt concepts, which in turn increase student’s knowledge, interest and perception thus promoting further learning and higher level thinking strategies.

In a study by Okere (2000) that surveyed the status of Physics teaching and examinations in Kenya secondary schools, revealed that teachers do not use field trips and hardly use the project method in their teaching. The findings showed that teachers do not employ field trip activity strategy in their teaching despite many sites being around their schools which can be visited for the purpose of learning.

Despite the learning and teaching associated with field trip and science club activities, teachers rarely use them in teaching Physics. Considering the fact that the non-formal Physics curricular activities are on-going in Kenya secondary schools and the rest of Africa, there is need bridge the gap with developed countries who documented a lot on non-formal curricular. This is because there is no study available in Kenya and the rest of Africa which addresses problems teachers face when undertaking NFA in schools. Hence the need to generate empirical information on teachers' perception about NFA in Vihiga County by use of questionnaires and interview schedule.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Design

This study explored the influence of non-formal Physics curricular activities on students' perception and achievement in Physics in secondary schools of Vihiga County located in Western region of Kenya. The research employed a combination of the following designs; Quasi-experimental design, ex-post facto survey design and correlational design. The research used quasi-experimental because the independent variable was manipulated but participants of the study were not randomly assigned to the control and experimental group as the case of true experiments (Bhat, 2015).

The study used ex-post facto design since it was done after the students had participated in Physics non-formal activities of science club and field trip. Ex-post facto design entails examining the influence of a naturalistically occurring treatment after the treatment has occurred rather than creating the treatment itself (Mutuku, Mutiso & Mbatha, 2007; Tuckman, 1972). The independent variable for study was students' participation in non-formal Physics curricular activities while the dependent variables were students' perception and achievement in Physics.

The researcher related the treatment to dependent measures hence the study hence the research employed correlational design. The researcher compared participants and non-participants of the non-formal Physics curricular activities on the four (4) objectives of the study. The correlational design has the ability of describing behaviour, exploring phenomena, and testing hypotheses about behaviour in a natural setting (Brown, Cozby, Kee & Worden, 1999). Pearson correlational analysis was used to establish relationships between independent and dependent variables of the study.

The combination of the three designs also allowed drawing of more than one sample from a population at a time and carrying out an in-depth study of variables. Further, the designs enabled a researcher to describe the characteristics of a population or the differences between two or more populations and was be used to make a prediction about populations. In order to arrive at a unified view of different opinions held by students and teachers on non-formal Physics curricular activities, the design was ideal. Studies that investigate influence of participation in educational activities are done using quasi experimental design, ex-post facto design and correlation design (Babbie, 1979; Zechmeister, Shaughnessy & Zechmeister, 2006).

3.2 Study Area

This study was carried out in public secondary schools in the Vihiga County of Kenya. The county is found in the Western part of Kenya and is bordered to the east by Nandi County, to west Siaya County; on the south Kisumu County and to the north is Kakamega County. Vihiga County occupies an area of approximately 563 kilometres square with an estimated population of one million people (KNPC, 2009). The county generally receives high annual rainfall that enables the inhabitants to engage in a number of subsistence agricultural activities which sustain their lives. Tea was introduced in the county a few years ago and it is the only cash crop planted on small scale.

The county is densely populated and most people in it are relatively poor. The road network in Vihiga County is adequate and consists of both murram and tarmac roads. Cell phone network communication covers the entire County adequately; however, internet services are limited to use of modems and a few cyber cafes in urban centres. Appendix E shows the map of the area to be covered by the study.

Vihiga County has four (4) sub-counties as of the year 2017. The sub-counties are namely Vihiga, Emuhaya, Sabatia and Hamisi. The County is located in the Lake Victoria Basin between Longitude 34^0 30′ East and 35^0 0′ East and between Latitude 0^0 5′ South and 0^0 15′ North (Vihiga County Integrated Development Plan-CIDP, 2018). The County was selected as the site of study because of her poor performance in Physics at secondary school level as well as offering a variety of schools with different characteristics such as class size, high and poor performing schools, national schools, extra-county, county, boarding and day schools with teachers of varying qualifications, learners of various economic, social and academic backgrounds.

The other reason for choosing the county was that there are a variety of educational sites in the neighbouring counties which secondary school students regularly visit. The research was also based in Vihiga County because the researcher was interested in establish whether non-formal curricular activities of science club, science congress and field trips influence students' achievement in Physics.

Most secondary schools in Vihiga County have continued to post poor results in the Physics subject attaining mean scores of 3.42, 3.51, 3.31, 3.90, 4.01 and 3.85 in 2010, 2011, 2012, 2013, 2014 and 2015 respectively (Vihiga County QAS Report, 2016). The mean scores for the six years in Vihiga County are very much below average on a 12-point scale. Thus the need to establish the influence of non-formal Physics curricular activities on students' performance.

Furthermore, according to Strengthening Mathematics and Science in Secondary Schools (SMASS) in 2015, the overall mean score for Vihiga County in 2015 KSCE Physics was 3.85 representing a mean score of D(plus), which was below the national of 4.47 (Sogoni, 2017). The non-formal curricular activities were preferred because they nurture scientific perceptions and skills among students as they provide real life experience of the subject being taught. The activities are also necessary for producing a scientific literate society for technological advancement of the country.

Vihiga county had a total population of 1200 Physics students in form four who were distributed in 114 public and 4 private secondary schools. The number of Physics teachers in the county was 80 (Vihiga County Education Statistics, 2017). Schools in the county were classified as National, County and private schools. The schools are uniformly distributed throughout the county and a large percentage of them are found in the rural areas.

The school types in the county are; boys boarding, girls boarding and co-educational day. Students in Kenya, join secondary schools after passing the Kenya Certificate of Primary Examinations (KCPE) done at the end of Primary school cycle. Students with higher in KCPE marks are selected to National schools while those with lower marks join County schools. Public schools in the Vihiga County are funded by the government which pays part of the students' tuition and the remainder fee is paid in by parents.

3.3 Study Population

The target population for this study comprised 114 public secondary schools, 1200 four (4) form Physics students and 100 Physics teachers of Vihiga County in the year 2017 (Vihiga County Education Statistics, 2017). The form four (4) Physics students were chosen because they were completing their four years cycle of the secondary education hence having been exposed to science congress, field trips and club activities. The group was also significant because they had covered a large portion of the secondary school Physics syllabus and were sitting for KSCE examination at the end of the year. Physics teachers' population was significant since they are involved in planning, implementing and evaluating of both formal and non-formal Physics activities in secondary schools.

3.4 Sample size and Sampling Techniques

The sample for the study was selected through simple random sampling technique while taking into consideration locations of schools within in the county. The schools were stratified as Boys, Girls, and co-educational. A total of sixteen (20) secondary schools were selected after assigning a weight to each strata based on total number of schools in each category. From each selected school, 16 students were included in the study through simple random sampling with equal proportion of participants and non-participants of NFA, giving a sample size of 311 students selected based table for estimation for sample size (Krejie & Morgan, 1970; Yamane, 1967).

For schools which had more than twenty (20) Physics students, simple random sampling techniques was used to select twenty (20) students to take part in the research. A saturated sampling technique was used to arrive at 36 teachers of Physics from the sampled secondary schools were included in the study. Table 4 below shows how the study sample was arrived at.

Table 4: Sampling Frame

Respondents	Total Number	Number Selected	Percentage (%)
Form Four Students	1200	311	25.9
Teachers of Physics	100	35	35.0

Source**:** Researcher

3.5 Data Collection Instruments

Data collection instruments used in this study were Student Perception Questionnaires (SIQs), Teacher questionnaires, Teacher Interview Schedule and Physics Achievement Test (PAT). The instruments are discussed in detail as follows.

3.5.1 Student Perception Questionnaires

Student Perception Questionnaires were Likert scales adapted from Stephen (2006). It was divided into subsections A, B, C and D. The first section of each questionnaires captured students' personal details which included school, gender and non-formal activities participated in. The rest parts of the questionnaires consisted of fourteen (14) Likert scale evaluating learner perception towards field trip activities and science club activities

(Appendix A). The Likert scale had five (5) options of SD = "Strongly disagree", D = "Disagree", U = "Undecided", A = "Agree" (A) and SA = "Strongly agree". The Likert scale options were coded in a way that those statements seeking high perception, strongly agree (SA) option was given a score of 5 while statements seeking low perception strongly disagree (SD) option was given one (1) point. Alternatively, low perception seeking statements strongly disagree (SD) was given a score of five (5) while strongly agree was given score of one (1) point.

For example on the statement "When I participate in field trip activities my Physics marks improve" strongly agree option was given a score of five (5) since the statement high perception towards the activities as well as Physics subject. A student opting for "Strongly disagree" on the same statement was awarded a score of one (1), implying low perception towards Physics subject.

The statements on the questionnaire consisted of both domains of students' perception non-formal curricular activities and class work activities and each sub-section of the questionnaire had total scores ranging from a minimum of seven (7) to maximum of thirty five (35). This study operationalized students' total score on a subsection of the Student Perception questionnaire as perception towards Physics subject. The statements on the Likert scales asked students to rate whether the activities: improved their marks in Physics, improved their perception, assisted in learning Physics and handing in assignments among other statements.

3.5.2 Physics Achievement Test (PAT)

Physics Achievement Test (PAT) was designed by the researcher and had twenty (20) items of both short and long answer questions (Appendix C). The test was designed with help of table of specification with some test items adapted from Physics past papers questions at Kenya Certificate of Secondary Examination (KCSE) and past mock papers. The table of specification ensured that the test questions covered the seven levels of testing of knowledge, comprehension, application, analysis, evaluation and synthesis according to (Bloom's Taxonomy, 1956). Physics Achievement Test (PAT) tested all the levels of Bloom's Taxonomy with the highest percentage of the items being from application (26%) and the least cognitive level being synthesis (8%).The students' answered questions on the test and their score on the test demonstrated their achievement in Physics subject. Physics Achievement Test (PAT) had a maximum score of sixty (60) marks and students were allowed one hour and thirty minutes to do the test.

3.5.3 Teacher Perception Questionnaires

The teacher questionnaires were used to collect data on the challenges of implementation non-formal Physics curricular activities in secondary schools of Vihiga County. The questionnaire had three sections: section A was a Likert scale which was adapted from (Stephen, 2006) and sought information from Physics teacher's about factors and challenges affecting implementation of Physics non-formal curricular activities in secondary schools. Section B was also a Likert scale that asked teachers to rate reasons for organizing the non-formal activities in secondary schools and lastly a semi-structured interview schedule which asked teachers about learning outcomes they expected from the activities.

Some of the statements on the Likert scale asked teachers to rate reasons about the activities like relevance to teaching and learning process, improvement of students' interest and perception towards Physics, broadening students' view of Physics concepts and career choice as well as enabling students to travel to far place and compete for certificates. The second Likert scales had nine (9) statements and asked Physics teachers to rate reasons for involving students in the non-formal activities of science congress, field trips and science club.

The Likert scales had five options of SD = "Strongly disagree", D = "Disagree", U = "Undecided", A = "Agree" (A) and SA = "Strongly agree". The scoring of the scales was such that high perception seeking statements had strongly agree (SA) assigned a score of 5 points whereas low perception seeking statements had “Strongly disagree” (SD) given a score of one (1) point.

This was done to safeguard against unidirectional reactions to the statements by the respondents. A respondents’ maximum score on the Likert scale was 45 while the minimum score was 9. A minimum score of nine (9) on the Likert scale by a teacher respondent signified a strong disagreement and indicated low perception about the non-formal activity in question. A teachers’ maximum score of 45 on the tool signified a strong agreement with the non-formal activity hence high perception towards it. The scores were converted to percentage for easy interpretation. The teacher interview schedule assessed the general understanding and opinions about the influence of non-formal activities on students’ learning and academic achievement. The interview schedule gave further insights on the teachers’ perception about non-formal curricular activities as well as triangulated results from the student and teacher perception questionnaires.

3.6 Validity and Reliability of Instruments

3.6.1 Validity

According to Kerlinger (1991) validity of an instrument is demonstrated when it asks the right questions which are non-ambiguous. Sharma (2002) notes that validity is the degree with which inferences made on test scores are meaningful, useful and appropriate. In other words validity of the instrument ensures results of the study are true. The Teacher Perception Questionnaires (TPQs), Teacher Interview Schedule, Student Perception Questionnaires (SPQs) and Physics Achievement Test (PAT) were subjected to face and content validity.

This was done by four experienced secondary physics teachers, two academic supervisors and two science education lecturers in Maseno University. The items on the statements were assessed in items of language appropriateness and distracters. The research participants’ responses were obtained from a five-point Likert scale. The scores from the questionnaires were transcribed into a percentage score. An average score of above 70 per cent for face and content validity was considered appropriate for the research instrument. The average of the responses of the face and content validity of the research instruments are shown in Table 5.

Table 5: Summary of Assessment of Instrument Validity by Percentage

Instrument	Type of Validity	Physics Teacher	Academic Supervisors	Physics Educators	Average Percentage	Conclusion
TPQ1	Face	74	83	80	79.0	Appropriate
	Content	80	82	82	81.3	Appropriate
TPQ2	Face	81	75	76	77.3	Appropriate
	Content	79	76	73	76.0	Appropriate
TIS	Face	72	81	86	79.7	Appropriate
	Content	75	78	73	75.3	Appropriate
SPQ1	Face	79	70	69	72.7	Appropriate
	Content	80	76	75	77.0	Appropriate
SPQ2	Face	72	81	87	80.0	Appropriate
	Content	85	82	84	83.7	Appropriate
PAT	Face	80	78	70	76.0	Appropriate
	Content	89	80	82	83.7	Appropriate

Source**:** Researcher and Science Education Experts
TPQ1: Teacher Perception Questionnaire One,
TPQ1: Teacher Perception Questionnaire One,
TIS: Teacher Interview Schedule, SPQ1:
Student Perception Questionnaire One
SPQ2: Student Perception Questionnaire Two
PAT: Physics Achievement Test

3.6.2 Reliability

The reliability of an instrument refers to the consistency that it demonstrates when applied repeatedly under similar conditions (Zechmeister, *et al*., 2006). The reliability of Teacher Perception Questionnaires (TPQs), Teacher Interview Schedule (TIS), Student Perception Questionnaires (SPQs) and Physics Achievement Test (PAT) were ascertained using test-retest method. The instruments were administered twice to the same group of students after a two week lapse between the first and second admission. The correlation coefficients of the instruments were ascertained using Pearson correlation coefficient method (Gall, Borg & Gall, 1996).

The Pearson correlation coefficient of all the instruments were found to be above 0.7 which was large enough and each instrument was declared appropriate (Kerlinger, 1991) Table 6.

Table 6: Reliability Coefficients of Research Instruments

Instrument	Pearson (r) Value
Teacher Perception Questionnaire One (TPQ1)	0.75
Teacher Perception Questionnaire Two (TPQ2)	0.73
Student Perception Questionnaire One (SPQ1)	0.80
Student Perception Questionnaire Two (SPQ2)	0.82
Physics Achievement Test (PAT)	0.83

Source: Researcher and Science Education Experts

3.7 Data collection Procedures

This study was approved by the School of Graduate Studies, Maseno University and this also facilitated ethical approval by Maseno University Research Ethics Review Committee which issued a research permit (Appendix F). The researcher also sought permission from the respective principals of secondary schools which were sampled for the study. This enabled the researcher to access the sampled school's compounds as well as the relevant departments to the study. Data for this study was collected between September and October 2015. The researcher administered the questionnaires to the respondents in person with assistance of science club patrons and Physics head of subject.

The researcher made clarifications about the questionnaires to respondents and in the process assured them that the responses were only for the purpose of the study. The researcher further assured the respondents that their identity and opinions will be kept private and confidential. The Physics student respondents were allowed thirty minutes to fill the questionnaires. The Physics Achievement Test (PAT) was administered by the researcher and Physics Heads of Subject during double lessons in the respective schools sampled for the study

3.8 Data Analysis

During data collection, the researcher checked all questionnaires for omissions in entries and discarded incomplete questionnaire. Data analysis adopted descriptive and inferential statistics of frequency counts, percentage, mean, standard deviation, Pearson correlational and t-test. Pearson correlational analysis was applied to give the relationship between the independent variables and dependent variables while t-test was used to determine difference perception and achievement for participants and non-participants on non-formal activities (Gall *et al* 1996). The dependent variables for this study were student perception and achievement in Physics while the independent variables were scope of participation in field trip activities and science club activities. The analysis lead to description of teachers' and students' involvement in non-formal Physics curricular activities.

Before data analysis was carried out all schools, teachers and students were assigned codes. Schools were given numerical code ranging from one (1) to sixteen (16). Teachers were alphabetical codes starting with letter "A" and ended with letter "H". Student's codes were combination of the school code and numerical values starting with one for student number to be sample. The Likert scale questionnaires used for this study were also coded and scored on a 5-point scale and gave the magnitudes of the constructs that were under investigation.

One (1) was the lowest score on the Likert scale while a score of Five (5) was the highest score for every item of the questionnaire. The Student Perception Questionnaires (SIQs) were composed of both items on Non-formal activities (NFA) and conventional class work, the two domains allowed for comparison between participants and non-participants of non-formal Physics activities.

The data from the questionnaires was analysed and reported as frequencies counts, percentages, means, and standard deviations. Data sets were also summarized in figure forms and analyses proceed as per the research objectives and questions. Physics Achievement Test

(PAT) was scored by the researcher himself using a marking scheme that had several alternative answers that catered for varied students' responses on the test. Quantitative data responses from the questionnaire were discussed using frequencies, percentages, means, and standard deviations.

A comparison between participants and non-participants achievement and perception was carried out by Pearson Correlation coefficient at 95% confidence level ($p < .05$). An independent t-test was used to establish the difference between the perception and achievement for participants and non-participants at 95% confidence level ($p < .05$). This enabled the researcher determine whether participating in non-formal Physics activities influenced students' achievement and perception in Physics. The statistics used to analyse the four objectives of the research are summarized in Table 7.

Table 7: Objective and Analysis Statistic

Objective	Statistic	
	Descriptive	**Inferential**
1.Establish influence of participation in field trip activities on secondary school students' achievement in Physics	Frequency, percentage, mean and standard deviation	Correlation and t-test
2.Establish influence of participation in field trips activities on secondary school students' perception in Physics	Frequency counts, percentage, mean and standard deviation	Correlation and t-test
3.Establish influence of participation in science club activities on secondary school students' achievement in Physics	Frequency, percentage, mean and standard deviation	Correlation and t-test
4. Establish influence of participation science club activities on secondary school students' perception in Physics.	Frequency, percentage, mean and standard deviation	Correlation and t-test

Source: Researcher and Science Education Experts

3.9. Ethical Considerations

According to Elyn (1991) ethical issues are very critical in research and their implications are not limited to the methodology sections only. Addressing ethical questions related to research ensures that the research process does not expose participants to physical or psychological injuries or risks (Fowler, 1993), hence strategies are put in place to minimize the same. The use of Student Perception Questionnaires (SIQs), Teacher Perception Questionnaires (TPQs), Teacher Interview Schedule (TIS) and Physics Achievement Test (PAT) in this research ethically obliged honest representation and analysis of information extracted from the documents because they represent personal views, beliefs and values of the participants of the research.

In respect to this, the following ethical consideration were addressed as they were likely to arise from the actual conducting of the interviews, filling of questionnaires and students answering questions on (PAT). The following ethical sensitive issues were addressed in this study confidentiality of persons, data storage and informed consent of participants. The researcher addressed the likelihood of risks to learners and teachers while providing information and data in respect to Ministry of Education Science and Technology policies and regulations about non-formal Physics activities.

Confidentiality: Confidentiality ensured that research data collected concealed the identity of individual participants of the research due to the sensitivity of the information and data they provided. To ensure confidentiality the following were undertaken: (1) the respondents' names and their schools were not used anywhere in the study, (2) all questionnaires and Physics achievement test documents were coded to conceal the individual identities, (3) research results were presented in a general manner.

Informed Consent: This research involved interaction between researcher, education officers, principals, Physics teachers and students. During data collection the presence of the researcher in schools could have affected the responses of the research participants. To address this, the researcher carried along a research permit from Maseno University Ethics Review Committee (MUERC) and consent form (Refer Appendix D).

Prior to participants filling the questionnaires the researcher personally explained to them the purpose of the research and why they were involved in it. The explanation focused on each research objective and the researcher gave participants an opportunity to ask any questions about the research. The researcher made clarifications and assured the participant that their responses were only to be for the purpose of the research and were treated in confidence (Refer Appendix D).

Teachers and students who consented and were willing to divulge information filled a consent form before participating in the study. The consent form gave them the following options: the right to withdraw from the study at any stage, the right to refuse to answer any question they wished, the right to request the presence of another person during the interview, the right to read the interview transcripts and the right to change or withdraw anything they wished in the transcribed narratives.

Data storage strategies: Data obtained from the research was stored in both electronic files and hardy copies. The records were kept strictly confidential. Filled questionnaires and Physics Achievement Test papers were kept under lock and key, electronic files were coded and secured using passwords to protect unauthorized access. No personal information from the participants was included in the final report and that made it impossible to identify individual participants of the study, however, participants were given an opportunity to review and approve any material that was published.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Influence of Participation in Field Trips on Students' Achievement in Physics

Both qualitative and quantitative data was generated from the study questionnaires. Qualitative data was analysed based on emerging trends while quantitative data was analysed using Pearson correlation coefficient and independent t-test using SPSS version 16.0. Quantitative data obtained from the student and teacher perception questionnaires were summarized in frequency counts, percentages, mean score and standard deviations. The data captured included school type, student form, non-formal activities offered in schools, places visited for field trip activities students' score on PAT and students' score on Student Perception Questionnaire (SPQ).

The non-formal Physics curricular activities represented in this study were field trips activities and science club activities. The criterion for selection of students into the study was that they were to be in form four (4) and taking Physics subject. All Physics teachers in sampled schools and volunteered to take part in the study were included in the teacher sample.

The study involved three hundred and eleven students (n = 311) who met the criteria of being in form four and they filled all sections questionnaires well. The research sought to determine the influence of participation in field trip activities and science club activities on students' perception and achievement in Physics. In the study students' perception scores and PAT scores for participants and non-participants were compared to deduce influence of the activities.

4.1.1 Scope of Participation in Field Trip Activities

This study sought to establish the students' scope of participation in field trip activities in secondary schools of Vihiga County. Participation in non-formal activities was based on school records kept by the Physics teacher and science club patrons in the sampled schools. Table 7 presents numbers and percentages of students by gender and their participation in non-formal Physics curricular of field trip activities. The table 7 also provides the percentage of participants and non-participants relative to total sample of the study.

Table 7: Participation in Field Trip Activities

Category	Membership	Number	Percentage (%)
Participants	Yes	73	23.0
Non-participants	No	139	58.0
Non-committal	N/I	99	31.0
Total		311	100

N/I=Not indicated their participation level at all
Source: Research data

Table 7 indicates that field trip activity is not popular in secondary schools as reflected in small number of participants (n = 73), compared to non-participants (n = 139) who had never gone for a field trip in their secondary life. This indicates that field trip activities as an active method of teaching Physics is neglected by schools despite schools having buses and numerous sites to visit in the neighbourhood. Non-use of field trip activities was further revealed by (n = 99) 31% thirty one per cent of the students who indicated that they had never gone for field trips. Put differently, nearly 80 per cent of the total student sampled had never gone for field trip activities in their entire secondary school education cycle. This result is consistent with the finding of Vihiga County Quality Assurance and Standards report (QAS, 2011) which indicated that participation in field trips activities and science club activities in the county was on the decline and it stood at 25 percent of the total secondary schools population. Also in agreement with these results is Okere (2000) who surveyed the status of Physics teaching and examinations in Kenyan secondary schools and found that teachers hardly used field trips and project method in their teaching though sites to visit were available around their schools.

4.1.2 Students' Achievement in Physics

This study also explored students' achievement in Physics subject in Vihiga County. In order to establish the students' achievement in Physics both participants and non-participants of field trip activities were subjected to Physics Achievement Test (PAT). Table 8 provides information about number, mean and standard deviation of participants and non-participants of field trip activities on Physics Achievement Test (PAT).

Table 8: Number, Mean and Standard Deviation for Participants and Non-Participants on Physics Achievement Test (PAT)

NFA	Statistic	Participants	Non-participants
Field Trips	Number	n=72	n=154
	Mean	18.07	18.64
	Standard deviation	7.78	6.65

Table 8, shows that participants and non-participants of field trips activities had almost similar performance on Physics Achievement Test (PAT) as revealed by the means and median scores which are far below the average score (M = 18.07 and M = 18.64) of the tool which stood at thirty (30) mark. The non-participants of field trips had slightly higher mean score (M = 18.64) on Physics Achievement Test (PAT) compared to participants (M = 18.07). The independent t-test was performed to compare participants and non-participants on PAT mean scores and the groups achievement were not significantly different, t (224) = 0.538, $p < .05$).

This indicated that the both participants and non-participants of field trip activities performed poorly on PAT. It was inferred that most secondary schools hardly exposed their students to field trip activities in spite of the schools having invested in ultra-modern buses which can facilitate visits to various sites for purpose of learning. These poor results on PAT were consistent with Kenya National Examination Council reports for the years 2006 to 2015 which indicate dismal performance in the subject. These findings signified a warring trend in the subject performance and efforts by key players in education sector are needed to avert this disturbing situation.

The results are also consisted with a report by Hartley (2014) which indicated that there were indications of limited success in examination and test achievement in science and mathematics by learners who participated in field trip but, on the whole, appeared to be on an upward curve. In agreement with results are Njoroge, Changeiywo and Ndirangu (2014) who observed that students' performance in Physics in Kenya Certificate of Secondary Education (KCSE) is generally poor and coupled with low student enrolment.

This finding are also consistent with Kenya National Examinations Council reports (KNEC) (2001, 2002, 2006, 2008, 2010, 2011, 2012, 2013, 2014 & 2017). These results contradicted with Adeyemo (2010) who observed that school based non-formal activities have significant influence on students' achievement in Physics. According to Adeyemo (2010) non-formal activities provide varied opportunities for learning, teaching, social interaction, physical and cognitive development of learners. Thus every child in a school should be given a chance to participate in at least one non-formal activity that suits his or her personal perception.

The findings also disagree with Marsh and Kleitiman (2002) who noted that students who participated in non-formal activities achieve better than non-participants. The researcher observed that non-formal activities have proven beneficial in building and strengthening academic achievement, regardless of their relation to academic subjects.

Poor achievement on Physics Achievement Test (PAT) by both participants and non-participants of the study can be explained by the fact most student's sampled lacked basic Physics concepts to enable them answer Physics questions. The teaching methods applied by most teachers in the schools seem to fail to illustrate Physics ideas and concepts at hand thus poor conceptualization by majority of learners and thus poor response from students on the Physics questions.

Traingualtion by interview was used to get more information from teachers on whether field trip activities influence students' learning and academic achievement in Physics. The study sampled thirty five (n = 35) Physics teachers, however, only egiht (n = 8) Physics teachers were interviewed. The teachers interviewed were Physics teachers ,Physics head of subject and science club patrons teaching. Table 9 provides teachers' characteristics of gender, number years of experience, number of teachers per category and the corresponding percentage.

Table 9: Teacher Gender, Years of Teaching Experience, Number and Percentage

Gender	Teaching Experience	Number (n = 35)	Percentage
Male 48 (91%)	0 – 4 yrs	10	19%
Female 5 (10%)	4 – 10 yrs	28	49%
	10 – 20 yrs	15	28%
	20 or more	2	4%

Table 9 indicates that a majority of teachers who participated in the study were male at 91 per cent while the female ones accounted for less than 10 per cent of the total population. This further confirms that Physics subject is dominantly taught by male teachers in Vihiga County. More than 80 per cent of the teachers sampled for the research had a teaching experience of more than four years and less than five per cent of the teacher had worked for more than twenty years. This indicates that a majority of teachers sampled for the study had been in the teaching profession long enough and could give informed responses to issues pertaining to application of NFA in teaching and learning of Physics in secondary schools.

It can also be concluded that a majority of sampled teachers in the study had enough experience to teach Physics subject. This low number of female Physics teachers is consistent with a study on determinants of girls' low enrolment in Physics in Secondary in Kajiado North Sub-County, Kenya by (Mwangi, Gongera & Thinguri, 2013). The study found out that few girls enrolled in physics in the Sub-county as compared to enrolments in Biology and Chemistry which had relatively large numbers of girl students and subsequently this was reflected among Physics teachers later in life.

The gender disparity observed in this study among students and teachers in Physics subject in Vihiga County could be attributed to the fact that the subject still is stereotyped as masculine, difficult and abstract for the girl child. Equally, the teaching methods applied in the schools may not be resonating with perception of the girl child of Physics.

The following questions were possed to Physics teachers (n = 6) by researcher to determine whether field trip activities influenced students' achievement and learing:

Question 1. Do field trip activities influence students' learning of Physics?

Teacher A from school 1 with teaching experience of fifteen years responded by saying that:

> "*When a learner observes real application of what is taught in a classroom ….obviously his/her thinking about the content or subject matter will be more focused than before…. this can easily allow further questioning of the content and lead to deep understanding of subject matter…….definitely this will enhance Physics learning.".*

Teacher B from school 3 with seven (7) years of teaching experience said that:

> *"Field trip activities make teaching and learning more interesting, easier, and more diverse, more fun for teachers and students…….compared to the convectional classroom teaching employed by many teacher in schools"*

Teacher C from school 3 with three years of teaching experience simply noted that:

> *"Field trip activities add variety to teaching methods…………it engages the learner in active construction of knowledge by providing vivid displays of phenomena*

which easily excite the learner and provoke useful and meaningful learning. This kind learning is long lasting due to the memorable objects observed….."

Teacher G from school 14 with ten years of teaching experience emphasized that:

"*Field trip activities…. One, add variety to teaching. ….. Second, they are motivating for students. …….Thirdly, sometimes it is the best way to teach abstract content hence influencing learning of Physics".*

Question 2. Do field trip activities influence academic performance in Physics subject?

Teacher E from School 10 with twenty years of teaching experience said that;

"Field trip activities influence academic performance of learners, not real sure……but, maybe along after the field trip has taken place……..that is because field trip learning general motivates hence students can study hard and perform well in Physics..."

Teacher H from school 4 with ten years of experience noted that:

"*Field trip activities are useful in enhancing Physics subject matter skills and they bring about creativity and innovation particularly with limited laboratory resources".*

The teachers (n = 6) interviewed had used field trip activities in teaching and learning of Physics subjects. Some of the sites the teachers visited with their students were airports, power generation stations, sugar industries and hospitals. On analysing the teachers' responses the following themes emerged: field trip activities enabled students visualize science concepts and hence prompted greater motivation towards Physics subject; made students to question what is observed hence provoking deep learning; field trip activities made learning and teaching more interesting as compared to conventional methods; enhanced students' memory of what is learned, promoted meaningful learning of abstract content; encouraged creativity and innovation among students after observing real application of Physics laws and principle and enabled students to develop positive attitude towards the subject.

This results concur with Michie (1998), Fido and Gayford (1982) who argued that taking out students for field trip activities general give students' first-hand experience of application of Physics and the activities an effective pedagogy which supplements classroom teaching. The findings are in agreement with Eriacho (2009) who asserted in a study in Nigeria that students' interest and motivation from field trip activities have a high positive correlation with academic performance.

4.2 Influence of Participation in Field Trip Activities on Students' Perception of Physics

The second objectives of this study sought to establish the influence of participation in field trip activities on students' perception towards Physics subject. Both participants and non-participants of field trips were asked to indicate on fourteen (14) statements of Student Perception Questionnaire One-SPQ1 (Appendix A), how often they practiced particular tasks in their Physics classrooms. Each statement on SPQ1 was tallied and a student's total score on the questionnaire was computed. A student's total score on SPQ1 was operationalized as the student's perception towards Physics subject.

4.2.1 Students' Perception of field Trip Activities

Students' perception of field trip activities was operationalized as a score between 14 and 35 on Student Perception Questionnaire One –SPQ1 (Appendix A). A student's score of 14 on SPQ1 signified that the student had low perception towards field trip activities while a score of 35 meant high perception towards the activities. Student perception questionnaire consisted of several classrooms tasks grouped under the following sub-headings: mark improvement; perception in Physics; teaching using field trips, class and laboratory teaching and handing in of assignments. The students' responses on each statement on SPQ1 were analysed using frequency counts, means and standard deviation. Table 10 presents means, standard deviation and interpretation (IP) perceived benefits of field trip activities for participants and non-participants form from Student Perception Question One (SPQ1).

Table 10: Means, Standard Deviations and Interpretation (IP) of Perceived benefits of Field Trips Activities for Participants and Non-Participants fromSPQ

Statement	Participants(n=72)			Non-participants(n=154)		
	Mean	SD	IP	Me1an	SD	IP
1) When I participate in field trips my perception of Physics improves	4.01	1.01	High	3.11	1.15	Moderate
2) Class work has helped me to improved my perception of Physics	4.59	0.64	High	4.27	0.74	High
3) When I participate in field trip my perception to learn Physics improves	4.38	0.83	High	3.47	1.21	High
4) Class work increases my perception to learn Physics	4.25	0.88	High	4.14	0.78	High
5) I like Physics when I am involved in class work	4.12	0.88	High	3.86	1.07	High
6) I enjoy Physics when we go for field trips	4.04	1.21	High	3.29	1.22	Moderate
7) I feel like a Physicist when we go for field trips	4.30	0.98	High	3.50	1.24	High
8) I feel like a scientist when we learn Physics in the classroom or laboratory	4.18	0.93	High	3.99	1.01	High
9) I understand the nature of Physics by going for Field trips (how Physics and Physicists work)	4.25	0.94	High	3.45	1.21	High
10) I understand the nature of Physics by learning in class (how Physics and Physicists work)	3.93	1.15	High	3.65	1.12	High
11)All Physics classes should incorporate more class work	3.49	1.24	High	3.24	1.38	Moderate
12) All Physics classes should incorporate more field trips.	3.71	1.37	High	3.52	1.27	High
13) I am more likely to hand in assignments when they involve field trips.	3.60	1.30	High	3.42	1.27	Moderate
14) I am more likely to hand in assignments when they are assigned to a class.	4.12	1.14	High	3.68	1.19	High
Group Mean	**4.06**	0.78	High	**3.36**	1.32	High

Source: Researcher. **IP**-Interpretation

It can be observed from Table 10 that of the total population of the students sampled in the study, less than a quarter (n = 72) had gone for Physics field trip activities while the rest were non-participants (n = 154). Table 10, shows that participants of field trip activities had “high” perception levels on all the statements of Student Perception Questionnaire one (SPQ1) while the non-participants registered eleven “high” and four “moderate” perception levels. This indicates that both participants and non-participants of field trip activities equally regarded the field trip activities as contributing to their learning and teaching of Physics. Contrary to exception, the non-participants rated the activities at high and moderate level of perception, this could be attributed to the fact that learners could have had prior exposure to field trip activities in other subjects of the school curriculum.

On overall, it can be noted that participants of field trip activities had a high group perception mean score (M = 4.06, SD = 0.78) as compared to non-participants’ group perception mean score (M = 3.36, SD = 1.32). An independent t-test was performed on the group mean perception scores for participants and non-participants of field trip activities it revealed there was significant difference between perceptions mean score.

The field trip activities participants’ group perception mean score (M = 4.06, SD = 0.78) and the non-participants’ group perception mean score (M = 3.36, SD = 1.32) were found to be significantly different, (t (222) = 4.473, p <.05). The t-value of 4.473 obtained was greater than the critical value at 222 degrees of freedom at p-level of .05. The difference in the perception in group mean scores could be attributed to exposure to field trips activities which enabled the real application of Physics in real life situations. This implies therefore field trip activities supplement classroom activities in teaching and learning of Physics in secondary schools.

Table 10, still indicates that participants of field trips activities had a slightly high perception mean score of (M = 4.38, SD = 0.83) on the statement that when I participate in field trips my perception towards Physics improved as compared to non-participants’ perception mean score of (M = 3.47), SD = 1.21). Participants also registered high perception mean score (M = 4.59, SD = 0.64) on the statement that class work improved in Physics mark as compared to non-participants who had perception mean score (*M* = 4.27, *SD* = 0.74). Participants of field trips activities had high perception mean score (*M* = 4.30, *SD* = 1.21) as compared to non-participants mean score (*M* = 3.50, *SD* = 1.24) on the statement “I like Physics when I go for field trips”.

This implies that despite field trips activities being rare in many secondary schools of Vihiga County, students still regard them highly as teaching tools. This result concur with Anderson et al. (2006) who noted that fieldwork had a positive impact on long-term memory due to its memorable activities. Anderson *et al*. (2006) noted further the field trip activities reinforce affective and cognitive domain as well as provide a bridge for higher order learning. In agreement with the findings are Ng and Nguyen (2006) who noted that non-formal activities especially academic oriented motivate learners because they provide real life contexts which make Physics more relevant.

As such this improves students’ conceptualization and understanding of Physics phenomena because field trip is an active method of teaching. In a similar study, Ajaja (2010) found that Biology teachers who took students for field trips in Biology subject believed that field trip activities enhance understanding of science process skills, and also improved student’s attitude towards science and in particular Biology.

Also in agreement are Behrendt and Franklin (2014) who noted that well undertaken field trips activities offer an opportunity to motivate students by allowing them to connect classroom concepts with reality thus promoting further learning and higher order thinking strategies. With higher understanding comes confidence and intrinsic motivation the researchers noted. Further, the results concurred with (Moriana, Alos, Alcala, Pino, Herruzo & Ruiz, 2006) who found that students involved in activities outside the school day had slightly better perception scores and academic performance, specifically for those who participated in academic related activities.

4.2.2 Summary of Scores on Perception of Field Trip Activities

Table 11 below gives summaries of number, mean and standard deviation for participants and non-participants from the student perception questionnaire one (SPQ1) from Table 11.

Table 11: Summary of Number, Mean and Standard Deviation of Participants and Non-Participants for Field Trip Activities

NFA	Statistic	Participants	Non-participants
	Number	n = 72	n = 154
Field Trip SPQ1	Mean	56.34	49.96
	Standard deviation	7.22	8.06

From Table 11 illustrates that non-participants of field trip activities (n =154) were almost double the participants (n =72) of the activities. Contrary to expectation, field trip activities participants had scored low on Physics Achievement Test (PAT) (*M* = 18.07 refer Table 8) but recorded the high perception mean score (*M* = 56.34) perception scores Table 11. A participants' perception score (*M* = 56.34, *SD* = 7.22) was high than those of non-participants' (*M* = 49.96, *SD* = 8.06). An independent t-test performed on the two perception mean scores found a significant different (t (224) = 6.35, p <.05).

This significant difference showed that participants of field trip activities highly regarded the field trip activities as contributors to their learning of Physics as compared to non-participants. This further illustrated, perhaps, there is need of more efforts to sensitize secondary school administrators and other education stakeholders to provide opportunities to students to undertake field trip activities regularly. This will enable students and teachers to take advantage of learning and teaching that takes place from the activities.

According to Hartley (2014) field trip or field work activities well organised and undertaken developed positive attitude and perceptions towards science among learners. By taking advantage of greater sense of understanding and appreciation for scientific endeavours in field trip activities student improved their learning (Hartley, 2014). A report by Hartley which covered various countries and contexts also identified the use of field trips as a positive addition to the learning of science since it brought up culture of science learning as more and more learners wanted pursue science.

The finding that field trip activities greatly influence the perception of a majority of learners in secondary schools can be attributed to the fact they present unique opportunities for involvement and are centred on hands on and mind on. As a result students experience and take in science concepts using almost all their senses hence the improved motivation and perception towards the activities.

4.2.3 Correlation between Field Trip Activities Perception and Physics Achievement Test (PAT)

To obtain the relationship between students' perception in field trip activities and achievement in Physics, a correlation test was run for students' scores from Student Perception Questionnaire One (SIQ1) and Physics Achievement Test (PAT) for both participants and non-participants. The students' number, means, standard deviations and Pearson moment correlations on PAT and SIQ1 variables for participants and non-participants of field trips activities are displayed in Table 12.

Table 12: Variable, Numbers, Means, Standard Deviations and Correlation Coefficients for Participants and Non-Participants on PAT and SPQ1- Field Trips Activities

Variable	Participants		Non-participants	
	PAT-participant	SPQ1-participant	PAT-non	SPQ1-Non
Number	n = 72	n = 72	n = 154	n = 154
Mean	18.07	56.34	18.64	49.96
Standard Deviation	7.78	7.22	6.65	8.06
PAT participant	1	.238*		
SPQ1-participant	.238*	1		
PAT-non			1	.198*
SPQ1-participant			.198*	1

*Correlation is significant at the 0.05 level (1-tailed).
PAT-non- PAT scores for non-participants
SPQ-non- Student Perception Questionnaire scores for non-participants

It is evident that non-participants (n = 154) of field trip activities outnumbered participants (n = 72) from Table 12, It can also be noted that non-participants of field trip activities had slightly higher mean scores on Physics Achievement Test (*M* = 18.64, *SD* = 6.65) than participants of field trip activities who had a low mean score (*M* = 18.07, *SD* = 7.78). However, participants of field trip activities scored a higher mean score on SPQ1 (M = 56.34, *SD* = 7.22) as compared to non-participants' mean score (*M* = 49.96, *SD* = 8.06). There is a significant variation in means scores by non-participants of field trip activities as demonstrated by significant differences in standard deviations obtained on SPQ1 (n = 154, *M* = 49.32, *SD* = 8.06) and on PAT (n = 154, *M* = 18.64, *SD* = 6.65).

There is insignificant difference in standard deviations for participants of field trip activities which shows slightly better consistent performance on both PAT (n = 72, *M* = 18.07, *SD* = 7.78) and SPQ1 (n = 72, *M* = 56.34, *SD* = 7.22). This indicates that performance of participants in field trip activities on PAT and SPQ1 was consistent while the performance of the non-participants of field trips activities was inconsistent. Positive significant correlations were recorded for both groups on PAT and SPQ1. However, the non-participants' Pearson correlation (r (154) = .238, p =.05) was slightly better than that of participants (r (72) =.198, p = .05).

The persistent inconsistent in means, standard deviations and Pearson correlation by both participants and non-participants in field trips could be attributed to the fact that very few students sampled for study had attended field trips activities. These results were inconsistent with Eastwell and Rennie (2002) who found a strong positive relationship between students' academic performance, perception and motivation with participation in non-formal science activities.

The results do not agree with Whitesell (2015) who found a small positive effect of exposure of students to field trips on science test score and proficiency examination in a study in New York. According to the two studies, participants in field trips activities were able to make informed connections between what is learned in the classroom and how the knowledge is applied in real life situations thus the improvement in their performance. The low contribution of field trip activities towards students' in Physics could be attributed to the low number of participants sampled in the study.

Using traingulation by interview the following questions were asked to Physics teachers to find out their perceptions' of field trip activities in secondary schools of Vihiga County. The seven (n = 7) teachers interviewed had taken students for field trip activities either in the school neighbourhood or far sites. Their typical comments on their perceived benefits of field trip activities are presented as follows:

Question 3. What are the benefits of involving secondary school learners in field trip activities?

Teacher A from school 1 with teaching experience of fifteen years responded by saying that:

> "*Field trip activities whether inside the school or outside the school breaks monotony of classroom teaching. The activities promote understanding of Physics concepts among students. The activities encourage group discussion on what is observed during the visit… "*

Teacher B from school 3 with seven years of teaching experience responded by saying that:

> *"Field trip to an industry will enable learners see and observe operation of motors and other machines which are not available in school. It is more interesting for students to be taken to an airport or air strip or even a port. The students will see real applications of Bernoulli's principles, Archimedes' principles taught in the Physics syllabus…………….. These aspects of Physics teaching cannot be achieved in a regular classroom or laboratory setting"*

Teacher D from School 7 with five years of teaching experience observed that:

> *"For example a simple field trip activity to a Kenya power electric transformer in the neigbourhood of a school will enable students visualize concepts like hysteresis and eddy currents which are quite abstract in reality. This is possible because students will be able to listen to the noise from the transformer caused by the two factors………furthermore, a visit to the transformer makes students also realize that what is taught in the classroom and laboratories has immediate application in the society".*

Teacher H from school eight (8) with 12 years of teaching experience noted that:

> *"Field trip activities enable learners to recall previous learned knowledge easily and this assists in connecting with new knowledge to be acquired…thus helping learners cultivate interest in the subject".*

Question 4. Are field trip activities well supported by school administration?

Teacher C from school 3 with three years of experience had to say this:

> "*… school administrators normally support field trip activities to the neighbourhood of the school which require no or minimal expenditure …, however, field trip activities to far places…. little or no support is given …..in fact we are normally remained that there is no budgetary allocation for the activities ….teachers are normally advised to ask parents of the students to fund the activities".*

Teacher E from School 10 with twenty years of teaching experience had to say that:

> *"It is difficult to organize a Physics field trip to a far place like a power generation station or airport …unless you ask parents to fund the field trip….. when parents are*

> *asked to fund the activities they hardly cooperate... so teachers hardly apply field trips in their teaching …"*

Question 5. What can be done to improve the field trip activities in secondary schools?

Teacher G from School 14 with fourteen years of teaching experience suggested that:

> *"Ministry of education should set aside some funds for taking Physics students out for at least one field trip either to an airport or industry. This will enable the students observe applications of most of the Physics laws and concepts covered in the syllabus. Physics laws and concepts are abstract and teacher explanation is inadequate. To make-up for the situation, I normally show students what is found round the school environment as long as it assists to achieve the syllabus objectives"*.

Teacher H from school eight with twelve years of teaching experience argued that:

> *"Use cheap and available field trip activities that can be found in the school environment to serve the purpose and the learning objectives stated in the syllabus. This will give students an opportunity to link theory and practice. Take students to "posho" mills, local garage, workshops and local hospitals"*

All the teachers (n = 7) interviewed had been teaching for over three years and had involved their students in field trip activities. The teachers' responses were analysed according to emergent themes. Teachers' perceived influence of field trip activities were as follows the activities broke monotony of classroom and laboratory improving the students perception of the subject, the activities enabled students visualize abstract concept, the activities enabled students make connection between classroom work and real application of the Physics hence linking theory and practice, the activities enable students perceive Physics as an important subject in the society and field trips enabled students recall previously learned materials hence providing connection concepts and ideas. The teachers interviewed suggested use of field trips activities in the school neighbourhood to mitigate the challenges of funding required for far site field trips.

The teachers' views that field trip activities provoked motivation and helped learners to engage in science subjects in particular Physics are consistent with those of (Ng & Nguyen, 2006). The researchers argued that field trip activities form real life contexts and make Physics and science in general more relevant and consequently improve students' conceptualization and understanding of given phenomena and hence promote learning. This finding also concur with Wilkinson (1999) who outlines the benefits of learning through contexts to include: student motivation and engagement as result of perceived relevant learning drawn from everyday real-life examples and phenomena, the development of critical thinking and problem solving skills with questions centred on a familiar context would lead to more effective learning

4.3 Influence of Participation in Science Club Activities on Achievement in Physics

The third objective of this study was to determine the influence of student participation in science club activities at secondary school level and their achievement in Physics subject. Achievement of participants and non-participants of science club activities were compared using their means scores they obtained from Physics Achievement Test (PAT).

4.3.1 Scope of Participation in Science Club Activities

Science club activities are timetabled to take place in the evening after normal classes and once every week of the school. Table 13 displays student enrolment in science club activities for secondary schools of Vihiga County sampled for the study.

Table 13: Enrolment of Students in Science Club Activities

Category	Membership	Number	Percentage
Participants	Yes	148	64
Non-participants	No	69	33
Non-committal	N/I	11	3
Total		311	100

N/I=Not indicated their participation level at all

From Table 13, over 60 per cent of the students sampled in the study were participants of science club activities. Less than 5 per cent of the students were non-commital about their participation in science club activities. This reveals that most students in secondary schools of

Vihiga County participate in science club activities. These finding contradict Quality Assurance and Standards report 2011 from Vihiga County (QAS Report, 2011) which indicate that participation in science congress, field trips, and science club activities is on the decline and stands at 25 percent of the total secondary school population in Vihiga County. However, this high participation in science club activities could be attributed to the fact that science club activities are run in most secondary schools throughout the year and forms the basis for participating in science congress activity which is an annual science competition organized by the Ministry of Education Science and Technology (MoEST).

4.3.2 Students' Achievement in Physics

Both participants and non-participants of science club activities were subjected to Physics Achievement Test. The difference in achievement on PAT between the two groups was tested using an indepented t-test. Table 14 displays a summary of number, mean score and standard devistion of participants and non-participants of science club activities on Physics Achievement Test (PAT).

Table 14: Achievement of Science Club Activities Participants and Non-Participants on Physics Achievement Test (PAT)

NFA	Statistic	Participants	Non-participants
Science Club Activities	Number	158	69
	Mean	18.52	18.20
	Standard deviation	7.44	7.45

Table 14 shows that participants (n =158, *M* = 18.52, *SD* = 7.44) and non-participants(n = 69, *M* = 18.20, *SD* = 7.45) of science club activities scored almost equivalent mean scores on Physics Achievement Test (PAT) and it was below the average on the tool of thirty (30). An independent t-test was run using mean scores of the two groups on PAT and no significant difference was found at t (225) = 0.802, p <.05. Overall, both participants and non-participants of science club activities did not perform well on (PAT), it can be inferred that a majority of secondary schools in Vihiga County expose their learners to science club activities. However, contribution of the activities to learning and teaching of Physics in secondary school was found to be insignificant.

These poor results on PAT are consistent with Kenya National Examination Council reports for the years 2006 to 2017 which indicate dismal performance in Physics subject throughout the country. These findings indicate a worrying trend in the subject performance and more effort is required to check this disturbing situation. These results disagree with Adeyemo (2010) who observed that any school based non-formal activities have significant influence on students' achievement in Physics. According to the researcher non-formal activities provide varied opportunities for learning, teaching, social interaction, physical and cognitive development of learners.

The findings also disagree with Marsh and Kleitiman (2002) who noted that students who participated in non-formal activities had better academic achievement than non-participants. The researcher observed that non-formal activities have proven beneficial in building and strengthening academic achievement, regardless of their relation to academic subjects. The low achievement in Physics Achievement Test (PAT) by both participants and non-participants of the study can be explained by the fact teaching methods applied by most teachers in the schools seem to be ineffective.

Traingulation by interview was again used to find out from Physics teachers whether science club activities influenced students' learning and achievement in Physics. The study had sample of thirty five (n = 35) Physics teachers but only four (n = 4) teachers were interviewed on this question. The interviewees were Physics teachers ,Physics head of subject and science club patrons teaching Physics subject.

The teachers' responses about the influence of science club activities on learning and achievement in Physics subject were as follows:

Question 1. Do science club activities influence students' learning of Physics?

Teacher H from school eight (8) with twelve years of teaching experience, described science club activities as a form of learning as follows:

> *"The activities motivate students to work together on science congress projects. As a result the students share their ideas and learning. The students in turn own their ideas and learning is enhanced as they feel of their belonging to discussion groups……"*

Teacher A from school l number one (1) said that:

> *"During science club activities students work in groups hence encouragement of cooperative learning.....learning from their peers"*

Question 2. Do science club activities influence academic performance in Physics subject?

Teacher D from school 7 with five years of teaching experience said that:

> *"Participants of science club activities generally become more acquainted with Physics content. Through the activities students easily understand Physics laws, principals and concepts hence improved performance in Physics examinations".*

Teacher A from school number one (1) with fifteen years of teaching experience, noted

> "*Science club activities provide learners with real world experiences which motivate them to learn Physics".*

Teacher C from school three (3) with three years of teaching experience noted that:

> *"Science club are enjoyable and motivating to students. The activities engage students in learning since they are generally learner centered"*

Based on the teachers' responses about the influence of science club activities on students' learning and academic achievement the following themes emerged. Teachers in general observed that science club activities have the following influence to teaching and learning of Physics: the activities foster cooperative learning, encouraged in depth of learning of Physics concepts, they are learner centred and provided real world experience which cannot be attained in a classroom environment.

The teachers further observed that the activities offered students with different styles of learning such as discussions, research and critical thinking. The teachers' views that field trip activities provoked motivation and helped learners to engage in science subjects are consistent with those of (Ng & Nguyen, 2006). The researchers argued that science club activities provide a real life contexts and make Physics and science in general more relevant and consequently improve students' conceptualization and understanding of given phenomena. As a result students' attitudes towards Physics improve and this makes the students' perceive the subject less abstract in nature.

4.4 Influence of Participation in Science Club Activities on Students' Perception of Physics

The fourth objective of this study sought to establish the influence of student participation in science club activities and their perception towards Physics subject. To achieve this the students sampled in the study were allowed to fill a student perception questionnaire two (SIQ2) and which was used to quantify students' perception mean scores.

4.4.1 Students' Perception of Science Club Activities

Students' perception of science club activities were captured using a Student Perception Questionnaire Two (SPQ2) (Appendix A) which was a five point Likert scale with extreme end alternatives of SD-Strongly Agree to SA-Strongly Disagree. Students were asked to rate a total of fourteen statements on SPQ2 on their perceived benefits of science club activities and conventional class work in relation with teaching and learning of Physics. The student's individual responses on each statement were analysed using frequency counts and finally summarized into mean scores and standard deviations. The total score on the questionnaire was operationalized as a student's perception towards Physics. Table 15 displays students' mean scores, standard deviation and interpretation (IP) of perceived benefits of science club activities for participants (n = 158) and non-participants (n = 69) from the sampled secondary schools.

Table 15: Mean, Standard Deviation and Interpretation of Perceived benefits of Science Club Activities for Participants and Non-Participants on SPQ2.

Statement	**Participants (n=158)**			**Non-Participants (n=69)**		
	Mean	SD	IP	Mean	SD	IP
1) Science club activities have helped me to improve my perception of Physics	4.16	0.81	High	2.72	1.13	Moderate
2) Class work has helped me to improve my marks in Physics	4.52	0.56	High	4.58	0.53	High
3) Science club has improved my perception to learn Physics	4.27	0.80	High	2.91	1.31	Moderate
4) Class work has improved my perception to learn Physics	4.31	0.55	High	4.53	0.62	High
5) I like Physics when we learn in class	3.88	1.14	High	4.17	0.97	High
6) I enjoy Physics when I participate in science club activities	4.07	1.01	High	3.01	1.10	Moderate
7) I feel like a Physicist when I participate in science club activities	4.37	0.74	High	3.03	1.21	Moderate
8) I perceive myself as Physicist when I learn Physics in the classroom or laboratory	4.09	0.96	High	4.39	0.88	High
9) I understand the nature of Physics by participating in science club activities (how Physics and Physicist work)	3.97	0.92	High	3.03	0.87	Moderate
10) I understand the nature of Physics by doing class work(how Physics and Physicist work)	3.85	1.09	High	4.22	0.92	High
11) All Physics lessons should incorporate more classroom work	3.06	1.41	Moderate	3.65	1.40	High
12) All Physics lessons should incorporate more science club activities.	3.66	1.28	High	3.17	1.24	Moderate
13) I am more likely to hand in Physics assignments when they involve science club activities	3.47	1.29	High	3.03	1.08	Moderate
14) I am more likely to hand in Physics assignments when they are assigned in the classroom.	3.78	1.21	High	4.01	0.97	Moderate
Group Mean	**3.96**	0.56	High	**3.60**	0.89	High

It can be observed from Table 15 that of the total population of students sampled, participants of science club activities (n = 159) were more than the non-participants (n = 69). Table 15, indicates that participants of science club activities had "high" level of perception on "all the statements of Student Perception Questionnaire two (SPQ2) except on the statement all Physics lessons should incorporate more classroom work" which they had a moderate perception level.

Table 15, still shows that non-participants of science club activities registered an equivalent number of "high" and "moderate" level of perceptions on the statements of SPQ2. This implies though science club activities are occasionally undertaken in secondary schools, participants of the activities highly rate them as contributing to their marks in Physics.

From Table 15, the difference between participants' overall group perception mean score (M = 3.96, SD = 0.56) and non-participants overall group perception mean score (M = 3.60, SD = 0.89) was found to be significant, (t (225) = 3.685, p <.05). Further, Table 15 shows that participants (n = 158) of science club activities had a high perception average score of (M = 4.16, SD = 0.81) on the statement science club activities helped me to improve my perception in Physics as compared to non-participants (n = 69) of the activities who had a perception average mean score of (M = 2.72, SD = 1.13).

On the statement "I enjoy Physics when I participate in science club activities", the participants had high perception mean score of (M = 4.07, SD = 1.01) as compared to the non-participants who had moderate perception mean score (M = 3.01, SD = 1.10). The same trend was observed on the statement that I feel like a Physicist when I participate in science club activities, participants registered high perception mean score (M = 4.37, SD = 0.74) as compared to non-participants' moderate perception mean score (M = 3.03, SD = 1.21). Similarly, on the statement I understand the nature of Physics by participating in science club activities (Physics and Physicist work), participants had high perception mean score of (M =

3.97, *SD* = 0.92) while non-participants had moderate perception mean scores of (*M* = 3.04, *SD* = 0.87).

Further, table 15 reveals that non-participants had high perception mean score of (*M* = 4.58, *SD* = 0.53) than participants' perception mean score (*M* = 4.52, *SD* = 0.56) on the statement class work helped me to improve my perception of Physics. Similarly, non-participant of science club activities had high perception mean score (*M* = 4.01, *SD* = 0.97) on the statement "I am more likely to hand in Physics assignments when they are assigned in the classroom" as compared to participants' medium perception mean score (*M* = 3.78, *SD* = 1.21).

The same trend was also observed on the statement "I feel like a Physicist when I learn Physics in the classroom or laboratory" non-participants' mean score (*M* = 4.39, *SD* = 0.88) as compared to participants' mean score (*M* = 4.09, *SD* = 0.96). Both the participants and non-participants had high perception means scores (*M* = 4.31, SD = 0.55) and (*M* = 4.53, *SD* = 0.53) respectively on the statement "class work improved perception to learn Physics".

The general trend indicates that science club activities contribute to Physics teaching and learning as much as class work and laboratory do. The findings show that though science activities are undertaken out of the school time table they still greatly influence students' perception. These results concur with Hartley (2010) who recommends science clubs as effective tool for not only promoting science communication but also as vehicles through which the teaching and learning of science subjects can be improved to increase the human resources of scientist, engineers, researchers and other careers.

In support of these results is PISA test (PISA in Focus, 2012) which identified successes of countries utilizing science-related non-formal activities to communicate and improve learners' participation, achievement and enjoyment of science. PISA notes that it is imperative that the communication of science and all the potential it holds for future generations be done in a manner that would draw young learners to science and to sustain their perception and involvement in school science but also in activities beyond the school formal curriculum. The finding also agree with Pike and Dunne (2011) who noted that the greatest challenge developing countries face is to ensure perception and enthusiasm for the learning of science at school level, with the numbers of learners taking up science and mathematics are decreasing on annual basis.

4.4.2 Summary of Perception Scores on Science Club activities

Student Perception Questionnaire two (SPQ2) incorporated both perception statements about class work and science club activities and catered for both participants and non-participants. Each statement on SPQ2 was tallied and students' total score on the questionnaire was obtained. A student's total score on each of the SPQ2 was operationalized as the students' perception towards Physics subject. Table 16 below gives summaries of number of participants and non-participants, their mean scores and standard deviations computed from student perception questionnaire two (SPQ2).

Table 16: Number, Mean and Standard Deviations for Participants and Non-participant of Science Club Activities

NFA	Statistic	Participants	Non-participants
	Number	n = 158	n = 69
Science Club SPQ2	Mean	54.62	49.32
	Standard Deviation	6.96	9.04

Table 16 illustrate that participants of science club activities had better perception mean scores (n = 158, *M* = 54.62, *SD* = 6.96) than non-participants of activities (n = 69, *M* = 49.32, SD = 9.04). The mean scores were subjected to an independent t-test and found to be significantly different, ($t(225) = 14.04$, $p < .05$). This findings showed that participants had better perception mean scores, signifying they highly regarded the science club activities as helping them learn Physics in secondary schools. This calls for more effort to sensitize secondary school administrators and other education stakeholders to provide students with opportunities to undertake science club activities regularly so as to take advantage of the learning that takes place in the activities.

This finding concurs with a study conducted in Nigeria by Nwankwo and Okoye (2015), found that science club activities positively improved secondary schools students' interest as well as their academic achievement in science and technology related subjects like Physics and Chemistry. Also in agreement with the finding is Hartley (2014) who noted that science club activities developed positive attitude towards science among learners. The finding that science club activities greatly influence the perception of the majority of the learners in secondary schools can be attributed to the fact that they presented unique opportunities for involvement and are centred on hands-on and mind-on. As a result the students experience science concepts using all their senses hence improved perception towards science subjects.

4.4.3 Correlation between Students' Perception and Physics Achievement

Pearson correlation coefficient was run for participants and non-participants of science club activities using scores from Physics Achievement Test (PAT) and Student Perception Questionnaire Two (SPQ2). Physics Achievement Test (PAT) represented students' achievement in Physics while Student Perception Questionnaire Two (SPQ2) measured students' perception towards Physics subject. Table 17 displays number of students, mean score, standard deviations and correlation coefficients for participants and non-participants on PAT and SPQ2 scores.

Table 17: Variable, Numbers, Means, Standard Deviations and Correlation Coefficients for Participants and Non-Participants on PAT and SPQ2-Science Club Activities.

Variable	Participants		Non-participants	
	PAT-participant	SPQ2-participant	PAT-non	SPQ2-non
Number	n = 158	n = 158	n = 69	n = 69
Mean	18.52	54.62	18.20	49.32
Standard Deviation	7.44	6.96	7.45	9.04
PAT-participant	1	.462*		
SPQ2-participant	.462*	1		
PAT-non			1	.379*
SPQ2-participant			.379*	1

*Correlation is significant at the 0.05 level (1-tailed).
PAT-non- PAT score for non-participant
SPQ2- Student Perception Questionnaire

Table 17 displays mean scores obtained from Physics Achievement Test (PAT) and Student Perception Questionnaire Two (SPQ2) for participants (n = 158) and non-participants (n = 69) which were used to run a Pearson correlation. Table 17, shows that participants (n = 158, *M* = 54.62) had higher mean score on Student Perception Questionnaire (SPQ2) than non-participants (n = 69, *M* = 49.32). Though participants' and non-participants' mean scores on PAT achievement test were almost equal in magnitude the participants' mean score (n = 158, *M* = 18.52) was slightly higher than that of non-participants (n = 69, *M* =18.20) by a positive deviation of 0.32 which is significant.

The highest variation in mean score was recorded for non-participants on Student Perception Questionnaire Three (SPQ2) scores (n = 69, *M* = 49.32, *SD* = 9.04) and the least variation was recorded for participants on Students Perception Three (SPQ2) scores (n = 158, *M* = 54.62, *SD* = 6.96). This result indicate that participants' perception was clustered to gather as compared to non-participants' perception towards Physics.

Overall, it's observed that the participants of science club activities out performed non-participants on both instruments (n = 158, *M* = 18.52, *SD* = 7.44) and (n = 69, *M* = 54.62, *SD* = 6.96) respectively. Furthermore, Pearson correlation coefficients for participants (*r* (158) = .462, $p<.05$) was more positive than those of non-participants (*r* (69) =.379) revealing that PAT performance positively correlated with perception in science club activities for both groups.

Therefore, this signifies that students' perception towards Physics positively influenced performance in Physics subject because the science club activities encourage science process skills which encourage critical thinking among learners. This research finding corroborated Lozano (2016) conclusion that non-formal curricular activities significantly influenced students' attitude, motivation, perception and academic performance. Other factors cited to influence academic achievement included students' background, parenting, and home learning activities even though remotely connected to classroom teaching or school curriculum. This finding also concurs with Wilson (2009) who notes that benefits of participating in non-formal activities include having better grades, having high standardized test scores, high educational attainment, attending more school regularly and having higher self-esteem.

Traingulation by interview was also used to get insights on teachers' perceptions about science club activities in secondary school of Vihiga county. The study sample had thirty five (n = 35) Physics teachers, however, only seven (n = 7) Physics teachers were interviewed. The teachers interviewed were Physics teachers ,Physics head of subject and science club patrons teaching Physics subject.

The teachers were asked to indicate benefits of involving students in science club activities. The teachers' typical comments on science club activities were as follows:

Question 3. What are the benefits of involving secondary school learners in science club activities?

Teacher B from school 3 with seven (7) years of teaching experience noted that:

> "*Science club activities are offered to students in schools after normal classes are over. Clubs enable students to understand abstract scientific concepts, processes and procedures. The activities improve students' attitudes since they are practical in nature".*

Teacher A from school 1 with fifteen years of teaching experience commented that:

> *"The activities enhance student achievement and interest in science and allow students to gain scientific inquiry skills and develop logical thinking as well as improve their communication skills"*

Teacher C from school 3 with three years of teaching experience said that:

> *"Students working on projects during science club activities develop high enthusiasm for scientific ideas and concepts since they are learning by doing".*

Question 4. Are science club activities well supported by schools administration?

Teacher D from school seven 7 with five years of experience lamented that:

> *"School administrators occasionally support science club activities especially during science congress competition………however, the support is minimal when science congress competition is over".*

Teacher F from school 15 with eight (8) years of teaching experience said that:

> *"School administrators are quite supportive of science club activities because the activities assist students prepare for science congress competition. The activities require little resources hence administrators are comfortable with them……"*

Question 5. What can be done to improve science club activities in secondary schools?

Teacher G from school fourteen (14) with ten years of teaching experience observed that:

> *"There is need to in service newly recruited teachers on how to run science club activities effectively. The teachers are generally frustrated with the activities due to of lack knowledge and skills to run them".*

Teacher E from school 10 suggested that:

> *"There is the need to in service science club patrons on how to search the internet for materials and information supplement science club activities. By using the internet the teachers can learn what is happening elsewhere in science clubactivities……..*
> *Furthermore, the teachers can start forums for sharing their respective science club*

experiences and this will lead to collaboration on matters of science hence leading to improved learning for teachers and their students……"

The teachers' responses about science club activities were analysed according to emergent themes. Teachers in general perceived that science club activities to have the following benefits to the teaching and learning process of Physics: science club activities enabled learners to understand abstract scientific concepts, processes and procedures; the activities improved students' attitudes towards Physics subject content and the activities improved students' inquiry skills and assisted to develop logical thinking and as well as improved students' communication skills. However, the teachers noted that School administrators only support science club activities during science congress competitions.

The teachers implored the need to embrace Information Technology Communication (ICT) and internet to improve the quality of science club activities. These findings concurred with Walden, Oni and Aladejana (2014) who argued that students' attitude and perception in Physics is a better predictor of students' performance in Physics and can be reinforced with science club activities. By using science club activities to promote perception and motivation towards Physics, achievement can be realized in Physics (Mbugua, Kibet, Muthaa & Nkonke, 2012).

4.4.4 Influence of Participation in Science Congress Activities on Physics Achievement

This study further looked at perception towards Physics arising from science congress activities which is a subsection of science club activities in secondary schools. Science congress activity is an annual science competition organised by the Ministry of Education Science and Technology (MoEST) for all secondary schools in Kenya and every secondary school student is eligible to participate in. Table 18 displays membership of students in science congress activities in secondary schools sampled for this study.

Table 18: Enrolment of Students in Science Congress Activities

Category	Membership	Numbers	Percentage (%)
Participants	Yes	155	65
Non-participants	No	60	25
Non-committal	N/I	23	10
Total		311	99

N/I=Not indicated their participation level at all

Table 18, indicates that over 60 per cent of the students sampled in this study participated in science congress competitions while less than 40 per cent did not. This clearly shows that science congress activities are popular in most secondary schools in Vihiga County. These results are contrary to Quality Assurance and Standards of Vihiga County report (QAS Report, 2011) which indicated that participation in non-formal activities is on the decline and stands at 25 percent of the total secondary school population in the county.

Figure 2 displays percentage of students and level of participations in Science Congress competition starting with school level up to National Science Congress competition.

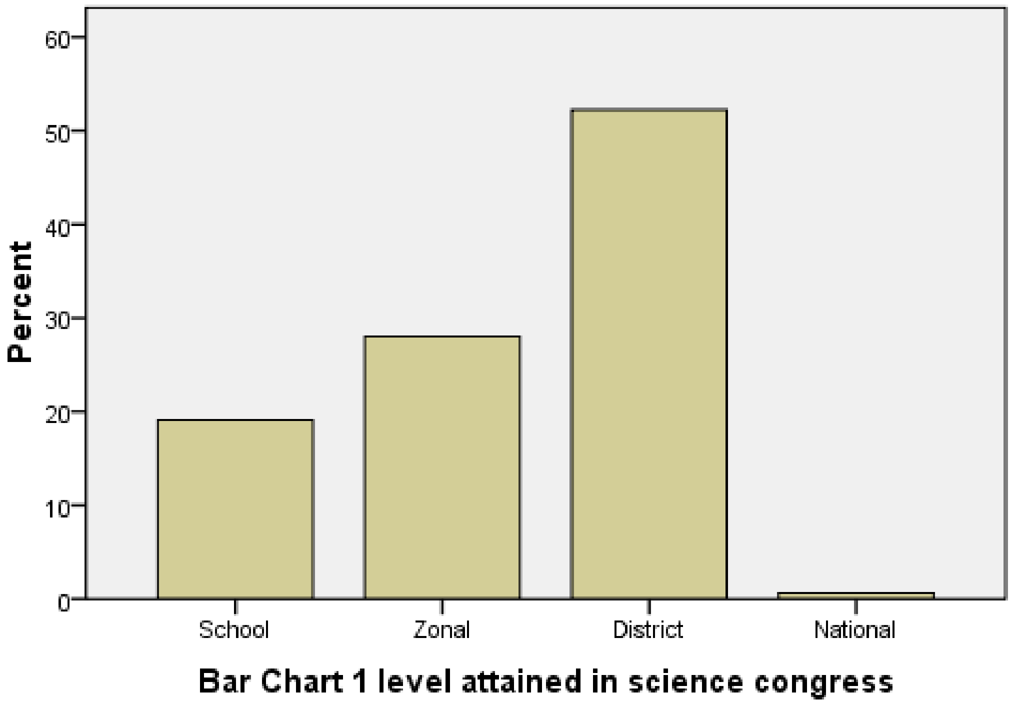

Figure 2: Level Attained in Science Congress

The Bar Chart indicates that over 50 per cent of the students sampled participated in science congress and only managed to reach the District level competition and about one per cent made it to the national level. This shows that Vihiga County was poorly represented at the National science congress competition and this calls for concerted effort from school administrators, science teachers and students so that many students can reach national science congress.

This could entail investing in early preparation, insisting on objective evaluation for projects, benchmarking with best performing counties as well as inviting resource persons to schools to guide teachers and students on how to effectively prepare for science congress competitions. About 20 per cent of the participants reached school level and slightly less than thirty per cent ended their competition at the zone level competitions. Table 19 shows the summaries of numbers, means and standard deviation for science congress activities participants and non-participants on Physics achievement test (PAT).

Table 19: Mean and Percentage Score of Science Congress Activities Participants and Non-Participants on Physics Achievement Test (PAT)

NFA	Statistic	Participants	Non-participants
Science Congress Activities	Number	161	66
	Mean	18.60	18.12
	Standard deviation	7.49	7.44

Table 19, shows that of the total sample of the study, participants (n = 161) of science congress activities were more than non-participants (n = 66). From Table 19 it is clear that participants and non-participants of science congress activity who had an equivalent performance on Physics Achievement Test (PAT) and performance was below the average of the tool of thirty (30) marks. A difference in the mean scores was tested using independent t-test and no significant difference was found, (t (225) = 0.422, p <.05) between the two PAT scores. This shows that both participants and non-participants of science congress activities fared poorly on PAT. Further, Table 19, still illustrates that despite there being a large number of participants of science congress (n = 161) they still registered a slightly higher mean score (M = 18.60) on Physics Achievement Test (PAT) compared to non-participants who had a mean score (M = 18.12). Overall, students sampled for the study did not perform well in (PAT).

These poor results on PAT for both participants and non-participants are consistent with Kenya National Examination Council reports for the years 2006 to 2014 which indicate dismal performance in the subject. These results are in agreement with Njoroge, Changeiywo and Ndirangu (2014) who observed that students' performance in Physics at Kenya Certificate of Secondary Education (KCSE) is generally poor. This is also consistent with Kenya National Examinations Council reports (KNEC) (2006, 2008, 2010, 2011, 2012, 2013, 2014 & 2015) which indicated general poor performance among learners in secondary school Physics.

Traingualtion by interview was further done to find out whether science congress activities influenced students' learning and achievement in Physics in Vihiga County. Although the study sampled thirty five (n = 35) Physics teachers, only six (n = 6) were interviewed. The teachers interviewed were Physics teachers ,Physics head of subject and science club patrons teaching Physics subject. The teachers were asked to indicate whether involving students in science congress activities influenced their learning and performance in Physics.

The teachers made the following comments about the influence of science congress activities on student learning and achievement:

Question 1. Do science congress activities influence students' learning of Physics?

Teacher C from school responded by saying:

> *"Science congress activities assist in construction of knowledge as students explore their ideas of interest. The activities are multi-sensory and multi-disciplinary".*

Teacher E from school emphasized that:

> *"Science congress activities entails working on projects….therefore it enhances hands-on activities which are important for teaching and learning science and in particular Physics".*

Teacher F from school 10 noted that:

> *"Science congress provides students with opportunities to practice science process skills. The students identify problems and try to get solutions to the problems using Physics laws and concepts. This in turn enables them learn Physics content deeply"*

Teacher H from school 8 argued that:

> *"Preparation of projects during science congress competition requires students to research and plan for the exhibits and talks……this involves critical thinking which is critical for Physics learning"*

Question 2: Do science congress activities influence academic performance in Physics subject?

Teacher B from school 3 stated that:

> *"Science congress activities encourage involvement of learners in conducting practical activities which promoted understanding of Physics concept hence improvement in their academic performance"*

Teacher F school 15 argued that:

> *"Science congress activities entail competitions therefore students who win at subsequent levels of the competition general get motivated and pursue Physics further…… as such learning from the activities increases….*obvious this can *enhance students perform in Physics and other science subjects".*

The teachers' responses from the interview were grouped in the following emergent themes: science club activities assist students to construct new knowledge as they explore phenomena practically; science congress activities enhance hand-on activities which can enable students experience meaningful learning; the activities also encourage science process skills which are critical for understanding science concepts; they also encourage critical thinking which is important for learning Physics and since science congress activity is a competition, winners at different levels get motivated and spent more time and energy studying Physics concepts hence improved academic performance.

This findings are in agreement witth Sahin (2013) who argued through after school programs, students learn how to work and communicate with their peers and teachers differently from their interaction in their regular classrooms. In a agreement with results is also Machie (1998) who noted that science competitions enable teachers and learners to utilise other learning strategies such as cooperative learning which enhance quality of education.

The study also captured students' perception towards Physics using student perception questionnaire three (SPQ3). The students were asked to rate statements on Student Perception Questionnaire Three SPQ3 (Appendix A) and score perception towards what was compiled from the questionnaire. Student Perception Questionnaire three (SPQ3) had fourteen statements, of a five-point Likert scale that measured students' perception towards Physics via science congress activities and classroom work. The Student Perception Questionnaire three (SPQ3) had statements related to classroom work which is the pre-dominant method of teaching Physics in secondary schools and applied to both participants and non-participants of science congress activities. The questionnaire statements were grouped into following classroom practices: Physics marks increased; perception increased; enjoyed Physics and handed in assignments. Table 20 gives the mean, standard deviation and interpretation (IP) of perceived benefits of science congress activities for participants and non-participants on Student Perception Questionnaire Three (SPQ3).

Table 20: Mean, Standard deviation and Interpretation (IP) of Perceived Benefits of Science Congress Activities for Participants and Non-Participants from SPQ3

Statement	**Participants(n=161)**			**Non-participants(n=66)**		
	Mean	SD	IP	Mean	SD	IP
1) Science congress has helped me increase my perception of Physics.	3.84	1.15	High	2.92	1.28	Moderate
2) Class work has helped me increase my perception of Physics.	4.00	0.57	High	4.35	0.86	High
3) Science congress has increased my perception to learn Physics.	4.35	0.88	High	3.25	1.22	Moderate
4) Class work has increased my perception to learn Physics	4.21	0.80	High	4.25	0.82	High
5) I like Physics when we do class work	3.80	1.07	High	4.07	0.97	High
6)I like Physics when I participate in science congress	4.03	1.08	High	3.00	1.11	Moderate
7) I feel like a Physicist when I participate in science congress activities	4.25	1.09	High	3.03	1.20	Moderate
8) I feel like a Physicist when I learn Physics in the classroom or laboratory	4.14	0.95	High	4.25	0.86	High
9) I understand the nature of Physics by participating in science congress (how Physics and Physicists work)	4.10	1.00	High	3.03	1.06	Moderate
10) I understand the nature of Physics by doing class work(how Physics and Physicist work)	3.83	1.15	High	4.14	0.89	High
11)All Physics classes should incorporate more class work	3.28	1.39	Mode rate	3.57	1.03	High
12) All Physics classes should incorporate more science congress activities.	3.59	1.32	High	3.13	1.19	Moderate
13) I am more likely to hand in Physics assignments when they involve science congress activities	3.47	1.33	High	3.00	1.19	Moderate
14) I am more likely to hand in Physics assignments when they involve assignment in the class.	3.90	1.18	High	3.97	1.09	High
Group Mean	**3.91**	0.69	High	**3.57**	1.05	High

Source: Researcher. **IP**-Interpretation

From table 20, it is evident that the overall group means of participants (*M* = 3.91, *SD* = 0.69) and non-participants (*M* = 3.57, *SD* = 1.05) were above the questionnaire average mean score of (*M* = 3.00). The discrepancy between participants' perception group mean score (*M* = 3.91, *SD* = 0.69) and non-participants' perception group mean score (*M* = 3.57, *SD* = 1.05) was found to be significant, (t (225) = 2.87, p <.05).

This indicated that participants agreed that both science congress activities and classroom work contributed to Physics instruction at secondary schools. From Table 20, it can be noted that participants of science congress activities had "high" perception on all statements of student perception questionnaire three (SPQ3) with exception for the statement all Physics classes should incorporate more class work which had a moderate perception towards Physics subject. The non-participants had equivalent number of "high" and "moderate" perception on the statements of SPQ3. This further signifies that almost all the students sampled in the study either agreed that both science congress activities and classroom work contributed positively to their learning of Physics in secondary schools.

Participants in science congress activities had high perception mean scores on the following statements: "science congress activities increased their perception in Physics" (*M* = 4.35, *SD* = 0.88); "feel like a Physicist" (*M* = 4.25, *SD* = 1.09) and "I understand the nature of Physics by participating in science congress activities" (how Physics and Physicists work) (*M* = 4.10, *SD* = 1.00). This could be attributed to the fact that science congress activities involve inquiry learning and teaching approach which entails designing, planning and investigating which assist in learning the content.

The least rated statements by science congress activities participants are: "all Physics classroom work should incorporate more class work" (*M* = 3.28, *SD* = 1.39) and "one is more likely to hand in Physics assignments when they are involved in science congress activities" (*M* = 3.84, *SD* = 1.15). In contrast, the non-participants of science congress highly rated “class work as helping them increase their perception in Physics” (*M* = 4.35, *SD* = 0.88), “class work increased their perception to learn Physics” at (*M* = 4.25, *SD* = 0.86) and “one felt more like a Physicists when they learned Physics in the laboratory” at perception mean (*M* = 4.10, *SD* = 1.00).

The perception high mean scores could be explained by the fact that non-participant in activities were only exposed to class work and laboratory activities while learning Physics hence their judgment. Notably, the least rated statements by the non-participants of science congress activities were that “Science congress helped to increase marks in Physics subject” (*M* = 2.92, *SD* = 1.28) and “One was likely to hand in Physics assignments when they were involved in science congress activities” (*M* = 3.00, *SD* = 1.11).

The students’ perception that science congress activities improved their Physics marks and perception is strongly supported by Behrendt and Franklin (2014) who stated that students who have perceptions and are alert in class. They learn concepts easily and their standardized test scores improve. These research finding are also supported by Bashir and Hussain (2012) who found out that non-formal science activities generally influenced students’ perception and academic performance. Also, in support of study finding, Eastwell and Rennie (2002) found a strong positive relationship between students’ perception and motivation and participation in non-formal activities. Research revealed that, students who participated in non-formal activities had high awareness on the value of scientists and science to the society.

Student Perception Questionnaire Three (SIQ3) incorporated perception statements towards class work and science congress activities and was meant to cater for both participants and non-participants of the activities. Each statement on SMQ3 was tallied and gave a student’s total score which represented the student’s perception towards Physics via science congress activities. Table 21 gives summaries of number of participants and non-participants, their mean scores and standard deviation from student perception questionnaire three (SPQ3).

Table 21: Summary of Number, Mean and Standard Deviation for Participants and Non-Participants of Science Congress Activities from SPQ3

NFA	Variable	Participants	Non-participants
	Number	n = 161	n = 66
Science Congress SPQ3	Mean	54.88	49.50
	Standard deviation	7.69	7.98

Table 21 illustrates variation between participants' mean score (*M* = 54.88, *SD* = 7.69) non-participants' mean score (*M* = 49.50, *SD* = 7.98) was found to be statistically significant, (t (225) = 4.728, p <.05), revealing that participants had higher perception towards Physics than non-participants as inferred from science congress activities. This findings therefore implied that participants in science congress activities highly regarded the activities as assisting them to learn Physics. This could be explained by the fact the activities enable the participants apply Physics concepts and principles in the projects the present during competitions hence increased internalization and conceptualization of the subject matter.

4.4.5. Correlation between Students' Perception and Physics Achievement

To determine the relationship between students' perception and achievement in Physics a Pearson correlation was run for participants and non-participants of science congress activities. Students' perception mean scores obtained from student perception questionnaire three (SPQ3) and achievement mean scores obtained from Physics Achievement Test (PAT). Student Perception Questionnaire three was a five point Likert Scale with options ranging from SA-Strongly Agree to SD-Strongly Disagree and measured students' perception to towards Physics based on science congress activities. Table 22 gives number of students, mean score, standard deviation and Pearson correlation coefficients for both participants and non-participants of science congress activities sampled in the study.

Table 22: Participants and Non-Participants Number, Means, Standard Deviations and Correlation Coefficient and PAT and SPQ 3- Science Congress Activities

Variable	Participants		Non-participants	
	PAT-participant	**SPQ3-participant**	**PAT-non**	**SPQ3-non**
Number	n = 161	n = 161	n = 66	n = 66
Mean	18.60	54.88	18.12	49.50
Standard Deviation	7.49	7.69	7.44	7.98
PAT-participant	1	.222*		
SPQ3-participant	.222*	1		
PAT-non			1	.183*
SPQ3-Non			.183*	1

*Correlation is significant at the 0.05 level (1-tailed).

Table 22 shows that total student population (n = 227) was sampled for the study a categorized as participants (n = 161) and non-participants (n = 66) of science congress activities. Participants had a slightly better mean score in Physics Achievement Test (n = 161, M = 18.60, SD = 7.49) as compared to non-participants (n = 66, M = 18.12, SD = 7.44). Participants' mean score (M = 54.88, SD = 7.69) in Student Perception Questionnaire three (SPQ3) was almost five points higher than the mean score achieved by non-participants in science congress activities (M = 49.50, SD = 7.98). The mean scores were found significantly different at t (225) = 4.728, p <.05 indicating that participants had higher perception towards science congress activities than non-participants. Notably, Table 22 illustrates that standard deviations for the four variables were all almost the same (SD = 7.5). This indicates that performances of the two groups in Physics Achievement Test (PAT) and Student Perception Questionnaire three (3) were consistent. Participants in science congress activities registered slightly higher Pearson correlation coefficient (r (161) = .222, $p < .05$), than the non-participants (r (66) = .183. $p <.05$).

Though, these results indicate Physics achievement was influenced by science congress activities, the number of participants in the sampled was overwhelmingly skewed towards participants. These results agree with Adeyemo (2010) who suggested that school based non-formal activities have significant influence on students' achievement in Physics. According to the researcher non-formal activities provide varied opportunities for learning, teaching, social interaction, and cognitive development. Thus every child in schools should be given a chance to participate in at least one non formal activity that suits his or her personal perception.

The findings also agree with Marsh and Kleitiman (2002) who pointed out that students who participate in any type of non-formal activities achieve better than non-participants. The researcher observed that non-formal activities have proven benefits of building and strengthening academic achievement regardless of their relation to subjects. Furthermore, the results concurred with (Moriana, Alos, Alcala, Pino, Herruzo & Ruiz, 2006) who found out that students involved in activities outside the school had better academic performance scores despite some activities having a remote relationship with subject.

This result agrees with Sahin (2013) who found that students who attended Science Technology Engineering and Mathematics (STEM) clubs had higher percentage of post-secondary admission in STEM related courses than the national average. Reasons advanced for this high admission from STEM club members include that students see applicability of the content they are learning in school, they are able to channel self-perception in a club into intrinsic motivation in the classroom to more fully participate in their club choices, or they may simply have a more creative environment with few restrictions on their learning and they persist in their STEM perception. Also in support of this finding is Nwankwo and Okoye (2015) who revealed that senior students in Anamba State in Nigeria testified that science club existed and functional in most secondary school in the state and had positive influence in increasing students' interest and achievement in science subjects as well as in science and technology related subjects.

The study was also traingulated by interview to get more insights on teachers' perceptions about science congress activities in secondary school of Vihiga county. The study sampled thirty five (n = 35) Physics teachers, however, only six (n = 6) Physics teachers were interviewed. The teachers interviewed were Physics teachers ,Physics head of subject and science club patrons teaching. The teachers were asked to indicate benefits of involving students in science congress activities.

The teachers typical comments on science congress activities were as follows:

Question 3. What are the benefits of involving secondary school learners in science congress activities?

Teacher A from school said:

> *"Science congress it involves students working in pairs to present exhibits and talks and that in itself fosters cooperative learning. Since students present their projects and exhibits during competitions….this improves their communication and presentation skills"*

Teacher C from school observed:

> *"Science congress activities involve travelling to different locations during the competitions………………..travel motivates students since they see new places and meet new people".*

Question 4. Are science congress activities well supported by schools administration?

Teacher G from school 14 said:

> *"Science congress activities receive overwhelming support from school administration…. the activities are included in the school calendar… therefore school administrator fund them promptly…."*

Teacher B from school 3 noted that:

> *"Secondary schools pay an annual fee to support the activities at zonal level, sub-county level, county level and regional level…. funds are available for the activities"*

Question 5. What can be done to improve science congress activities in secondary schools?

Teacher E from school 10 noted:

> *"Newly employed teachers lack necessary skills to support students in preparing science congress projects therefore the need to in service them"*

Teacher D from school said:

> *"The science congress activities need to be benchmarked with Olympiads competitions practiced in the industrialized countries by Ministry of education officials and science club patrons… this will ensure our students are exposed to recent developments in the field of science and technology".*

The teachers' responses from the interview about science congress activities were analysed and themes emerged. Teachers in general observed that science congress activities have the following benefits to teaching and learning process of Physics in secondary schools: the activities reinforced cooperative style of teaching and learning; improved students' communication and presentation skills; by developing science congress projects and exhibits for competition, students' skills of innovation and creativity improve and through travel students visit new places as well as meet people of different cultures. The teachers noted that the activities are well funded by school administrators. The teachers observed that science congress activities can be improved by benchmarking Olympiads practiced in the developed countries. In agreement with this finding is Fensham (1996) argued that pedagogically, an important aspect of teaching through science activities is fostering active construction of knowledge by student. This is because science activities generally promote cooperative and learner centred teaching and learning aspects of quality instructional processes.

This study was further triangulated by use of teacher perception questionnaire to establish general factors that affect implementation of non-formal activities (NFA) of science club activities, field trip activities and science congress activities in secondary schools. Physics teachers sampled were asked to rate Likert scale statements on availability of sites, finances, means of transport, time; school programmes schedules, site restrictions, administration, and relevancy of non-formal activities to examinations and teacher knowledge of integrating the activities in classroom learning. The teachers' responses on the questionnaire were summed up and percentages of the scores computed to give teachers' perception towards the non-formal Physics activities. High percentage score indicated teacher had higher perception towards the non-formal Physics curricular activities.

Table 23 below gives statements of perceived challenges teachers face and the respective percentage of teachers' responses per option of the Likert scale.

Table 23: Percentage and Mean Score of Teachers' Responses to Perceived Challenges for involving Students in Non-Formal Physics Activities (NFA)

Perceived Challenges	Percentage (%) responses					Mean Score
	SA	A	U	D	SD	
1.I lack knowledge to integrate activities in classroom learning	0.0	3.8	9.4	39.6	47.2	4.30
2.I lack sites for students to visits,	7.5	13.2	11.3	47.2	20.8	3.60
3.The school administration is supportive	7.5	28.3	13.2	34.0	17.0	3.25
4.Sites of visit have restriction on number of students to visit,	15.1	22.1	13.2	28.3	20.8	3.17
5.I lack time for activities	7.5	37.7	3.8	34.0	17.0	3.15
6.National examinations lack non-formal Physics activities questions	18.9	32.1	13.2	30.0	7.0	2.72
7.I lack means of transport to take students for the activities,	20.8	35.8	7.5	26.4	9.4	2.68
8.The school schedule is tight,	17.0	45.3	7.5	20.8	9.4	2.60
9.I experience financial constrains to undertake activities,	24.5	54.7	5.7	9.4	5.7	2.17

Source: Researcher.

SA-Strongly Agree, A-Agree, U-Undecided, D-Disagree, SD-Strongly Disagree

Table 23 shows that over 85 per cent i.e. (39.6 plus 47.2) (M = 4.30) of the total teacher population believed that they knew how to integrate the non-Formal Physics activities(NFA) of science congress, fieldtrips and science club in their teaching while less than 13 per cent agreed or were undecided about integration of the activities in classroom teaching. The results therefore show that a majority of teachers who participated in the study had the necessary skills and techniques for applying the NFA in the classroom.

In addition, Table 23 shows that over 65 per cent i.e. (47.2 plus 20.8) of the total teachers disagreed that sites to visit by students lacked a round their schools *(M* = 3.60). This indicates that teachers believed that several teaching and learning sites are within the county and the surrounding areas for students to visit and learn. School administrators were reported not to be in support for NFA activities by over 60 per cent of the teachers, however, slightly over than 35 per cent of the teachers indicated that their school administration were supportive while over 10 per cent of the teachers were undecided.

The finding further confirm that a fraction of school administrators do not support implementation of NFA activities and this could be attributed to their lack of knowledge of the positive impact of this activities on student learning of Physics and the other sciences. Of the teachers, 28 per cent disagreed and 22 per cent strongly disagreed that sites visited by students had restriction whereas 13 per cent were undecided and 37 per cent agreed.

This result implies that some sites visited by learners could accommodate large number of students while others could only take small group of students. A large number of students could be allowed on farms, plantations, natural features, power stations, big industries and airports while visits to hospital special units, banks and law courts numbers were restricted. Over fifty (50) per cent (18.7 plus 32.1) of the teachers disagreed that non-formal Physics curricular activities are not set in national examinations while 37 per cent agreed that the activities are set. These findings indicated that though these activities are not part of the conventional school curricular, they are captured in the examinations and therefore they are an avenue for learning and teaching of Physics. Even though a number of secondary schools sampled for the study owned school buses, still well over 55 per cent of the teachers (*M* = 2.66) reported that they lacked means of transport for undertaking NFA activities.

Only, thirty five per cent of the teachers noted that transportation means to take students to sites was not a hindrance at all. This implies that academic trips are generally given less priority by many school administrators and managers when planning for learning and teaching activities in their school calendars.

Half of the teachers in the study (*M* = 3.15) disagreed that lack of time was an impediment to carrying out NFA activities, though over 60 per cent of the teachers contradicted by a saying tight school schedule hindered the activities. From Table 23 more than 80 per cent of the teachers (*M* = 2.17) agreed that funding of non-formal Physics activities (NFA) in most secondary schools was a big challenge. This implies that most school budgets do not allocate funds for NFA activities thus denying students opportunities to learn from these novel activities which can visualize the real applications of Physics and science in life situations.

These finding concur with Sarker and Frazier (2008) who found that teachers had insufficient knowledge to integrate non-formal activities into classroom, teachers were unfamiliar with local resources available, lack of time to organize the activities and failure of schools administrators to allow for field trips impended use of field trips. Other factors cited to hinder implementation of NFA are: lack of funds, non-examination of such activities and the teacher's inability to manage groups of students outside the school.

Also in agreement with the finding is Dilon et al. (2006) who noted that lack of teacher confidence in teaching outdoors, insufficient of time, financial resources and support from school administration affect negatively the use of this effective teaching method. In agreement with teacher's revealed challenges to implementing Non-formal Activities (NFA) in schools are Brehrendt *et al*.(2014) who noted that the following are barriers to successful field trips: transportation; teacher training and experience; scheduling the activities; teacher's ability to prepare for trip; minimal administrators support for field trips and inflexibility in the school curriculum.

The finding that tight school schedules greatly affects implementation of non-formal activities (NFA) could be explained by the fact that current 8.4.4 system has been cited as being examination oriented and has led to neglect of some aspects of the curriculum which are necessary for modelling an all-round individual. Further, the finding that financial constrains restrict implementation of NFA could be explained by the fact that, though the government provides financial capitation for running secondary schools and has banned payment of extra levies, sufficient resources are not alocated to cater for all non-formal activiies (NFA).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

This final chapter of this study outlines the general overview of the study findings. It gives the results of the study and draws conclusions on them. It also gives recommendations as well as suggestions for future further research. The purpose of this study was to establish the influence of non-formal Physics curricular activities on students' perception and achievement in Physics. Literature reviewed indicated that both academic and non-academic non-formal activities (NFA) undertaken by students in school impacted positively their perception and academic performance. Some of the non-formal activities cited in literature to impact student's learning included sports, science competitions, science club, science fairs, drama, field trip, and visit to museums, music, clubs, debates and community engagements.

5.1.1 Field Trip Activities and Achievement in Physics

Field trip activities play a critical role in illustrating vividly Physics concepts hence enhancing conceptualization of the subject matter. However, the study revealed that few students participated in field trip activities in Vihiga County secondary schools. This implies the activities are underutilized by teachers and students despite there being many visiting sites in the neighbourhoods to assist in teaching abstract concepts. Furthermore, there was no significant difference between participants and non-participants mean scores on Physics Achievement Test (PAT). Contrary to expectation, the non-participants in field trip activities slightly outperformed the participants in field trip activities on PAT. Through interview, Physics teachers generally observed that field trip activities assist in conceptualisation of Physics concepts, motivate learners towards the subject, provoked deep learning and are more interesting compared to conventional methods. The teachers still noted that the activities enhanced students' memory, provoked meaningful learning, assiste in learning of abstract content and encouraged creativity and innovation among students.

5.1.2 Field Trip Activities and Student Perception of Physics

Students' perception of a subject has been cited in literature to influence achievement in the subject. The study revealed that perception group mean score for participants and non-participants of field trip activities were significantly different. The participants had high perception group mean score which was attributed to exposure to field trip activities which provided applications of Physics in life. This implied that field trip activities supplemented classroom activities in teaching and learning of Physics in secondary schools. The activities make Physics subject more relevant because they break monotony in presenting Physics concepts.

The study revealed that participants' mean scores on PAT and SMQ1 were consistent while for non-participants the scores were inconsistent as per standard deviation values computed. A positive significant relationship was found between participants' and non-participants' scores on Physics Achievement Test (PAT) and students' perception mean scores from SPQ1. The participants' Pearson correlation coefficient was more positive than that of non-participants.

By way of interview Physics teachers noted that: field trip activities broke monotony of classroom and laboratory teaching; enabled students to understand abstract concepts; assisted students to make connections between theory and practice and showed the application of Physics in society. The teachers interviewed suggested the use of school neighbourhood and environment to mitigate the challenges of poor funding of field trips in schools.

5.1.3 Science Club Activities and Achievement in Physics

Literature indicates that the science club activities improve students' achievement in science subjects. However, the current study established that mean scores of participants and non-participants of science club activities on Physics Achievement Test (PAT) was not significantly different and were below the average of PAT. Poor achievement in Physics Achievement Test (PAT) could be attributed to fact that most students' sampled in the study lacked basic Physics concepts to enable them answer Physics questions on PAT. The teaching methods applied by most teachers in the schools seem not to be enabling student's conceptualize the Physics content thus poor response by students on the PAT questions. Though, science club activities, seemed not to influence achievement on PAT, they provided varied opportunities for learning, teaching through social interaction as indicated by teacher and student sampled in the study.

Although there was no significant difference between PAT scores for participants and non-participants of science club activities, teachers interviewed in the study the noted that the activities foster cooperative learning, encouraged in depth learning of Physics, the activities are learner centred and provide real world experience of what is learned in the classroom. The teachers further observed that the activities offered students avariety of learning styles leading to critical thinking.

5.1.4 Science Club Activities and Student Perception of Physics

Science club activities positively influenced students' perception of Physics in Vihiga County. Participants of science club activities who were a majority in the study registered high level of perception on almost all the statements of Student Perception Questionnaire two (SPQ2) while the non-participants in the activities registered an equal proportional of high and moderate perception. This implies, though science club activities occasionally undertaken in secondary schools, participants in the activities rate them as highly contributing to their achievement in Physics. The participants' overall group perception mean score and non-participants' overall group perception mean score was found to be significantly different. Pearson correlation coefficients for participants on PAT and SPQ2 was more positive than that for non-participants.

Through interviewing of Physics teacher the following were noted: science club activities enabled learners to understand abstract scientific concepts, processes and procedures and hence improved students' perception of Physics. However, the teachers noted that School administrators only support science club activities during science congress competitions.

The teachers recommended use of Information Technology Communication (ICT) and internet to improve the quality of science club activities. It was concluded that science club activities supplemented Physics teaching and learning as much as class work and laboratory did.

5.1.4.1 Science Congress Activities and Student Achievement in Physics

The study found that less than one per cent of the student's sampled in the research managed to reach the national science congress competitions. Despite a large number of participants of science congress activities in the study, they still posted a slightly better mean score on Physics Achievement Test (PAT) as compared to non-participants though the mean scores were not significantly different. Participants of science congress activities registered a slightly higher Pearson correlation coefficient than the non-participants between perception and PAT mean score.

By use of interview Physics teachers noted that science club activities assisted students to construct knowledge and explore phenomena practically since the activities involve hand-on activities. This expedited critical understanding of concepts which ensued meaningful learning. Participants of science congress spent more time and energy studying Physics concepts hence improved academic performance.

5.1.4.2 Science Congress Activities and Student Perception of Physics

The results also indicated a slight positive correlation between students' perception of Physics and achievement on PAT. This revealed that performance in Physics Achievement Test (PAT) was to some extent influenced by science congress activities though the sample was skewed towards participants of the activities. Accordingly, science congress activities were observed to provide opportunities for social interaction and cognitive development of learners.

Participants' mean score in Student Perception Questionnaire three (SPQ3) was five points higher than the mean score achieved by non- participants in science congress activities. This indicated that participants in science congress activities had significantly higher perception towards Physics subjects as compared to non-participants.

Pearson correlation coefficients for participants in PAT and SPQ3 was more positive than that of non-participants. This suggested that students' perception inferred from science club activities influenced academic achievement in Physics subject since the activities encouraged science process skills of critical thinking, problem solving and creativity while designing projects for science congress competition.

Further, by way of interview the teachers had the following perceptions' of science congress activities in secondary schools reinforced cooperation among students, improved students' communication and presentation skills, made students innovative and creative. The teachers noted that the activities are well funded by school administrators and there is need to benchmark Olympiads practiced in the developed countries.

5.2 Conclusions

The place of Non-formal Activities (NFA) in the secondary school Physics curriculum cannot be ignored. From the results and literature reviewed it can be concluded that Non-formal

Activities (NFA) of Science club activities (SCA) and field trip activities have a positive influence on students' perception and achievement in Physics. In general Non-formal Activities (NFA) aid in contextualization of experiences and hence supplement and complement teaching and learning of Physics.

5.2.1 Field Trip Activities and Achievement in Physics

Field trip activities are quite significant in assisting students to learn abstract content since they enable them to see the real application of Physics. However, the study did not find a significant relationship between students' achievement on (PAT) and exposure to Physics field trip activities. This was attributed to few students having been exposed to Physics field trip activities in their four years of secondary education.

5.2.2 Field Trip Activities and Perception of Physics

Student's in secondary schools in Kenya were reported to perceive Physics subject as difficult and abstract. However, teachers, participants and non-participants in field trip activities in the study observed that the activities enhanced their perception towards Physics. There was a slightly positive correlation coefficient between participants' perception mean scores and Physics achievement mean scores as compared to non-participants on the same scores. This implies that participation in field trip activities improved students' perception Physics subject. It was therefore concluded that the field trip activities improved students' perception towards Physics thus could be used to improve achievement in the subject.

5.2.3 Science Club Activities and Achievement in Physics

The results showed that participants of science club activities (SCA) had slightly high mean scores on Physics Achievement Test (PAT) than non-participants but the means scores were not significantly different. Pearson correlation coefficient for perception scores and achievement scores were significantly different and favoured participants. This indicated that science club activities influenced achievement in Physics. The efficacy of science club activities was attributed to the fact they encouraged direct interaction between students and Physics concepts and hence enhanced easy conceptualization of Physics concepts. It was concluded that science club activities supplement conventional methods of teaching Physics in secondary schools.

5.2.4 Science Club Activities and Perception of Physics

Perception mean scores for participants in science club activities were over whelming higher than those of non-participants and they were found to be significantly different. The Pearson correlation coefficient between students' perception mean scores and achievement in PAT was also found to be significantly different and favoured participants. Therefore it was inferred that the science club activities positively influenced students' perception towards Physics subject.

5.2.4.1 Science Congress Activities and Achievement in Physics

Since there was no significant difference between mean scores of participants and non-participants on Physics achievement test (PAT), there is need to re-examine science congress activities with a view of enriching activities so as to supplement Physics learning schools. The fact that both participants and non-participants performed poorly on PAT was attributed to lack of skills, content and concepts by learners to handle questions Physics.

5.2.4.2. Science Congress Activities and Perception of Physics

Participants in science congress activities registered relatively high perception mean scores than non-participants. There was also a significant positive Pearson coefficient correlation between participants' perception mean scores and achievement in Physics. As a result it is concluded that science congress activities improved students' perception of Physics.

The study found out that minimal or no financial resources are allocated to the non-formal activities and parents mostly funded the activities. The Non-formal activities (NFA) supplement classroom work by enabling students to clarify and contextualize concepts as they observe them in their natural setting. This enables students to realize the relevance and application of knowledge, skills and content learned in the classroom and school laboratories. This in turn reinforces their perception and motivation to purse the subject further.

5.3 Recommendations for Policy

This study has contributed to the literature that by providing empirical information on the influence of non-formal activities on students' perception and achievement in Physics. The study established that non-formal Physics curricular activities exert potent influence on students' perception and achievement towards Physics. The study revealed that perception mean scores for participants and non-participants were significantly different. A high positive relationship was found for participants' perception scores and achievement in Physics as compared to non-participants. Due to the significance of non-formal activities in teaching and learning of Physics a number of recommendations for policy are made.

5.3.1 Field Trip Activities and Achievement in Physics

The Ministry of Education Science and Technology Kenya using its elaborate administrative structure should co-ordinate field trip activities in both primary and secondary schools. The ministry should compel school administrators to include the activities in their annual plans so that students are exposed to real application of science in the society they live. There is also need for the Ministry of Education address impediments that hinder the implementation of field trip activities in schools

5.3.2. Field Trip Activities and Perception of Physics

Since field trip activities participants' perception score were higher than those of non-participants, therefore there is need to sensitize stakeholder in education sector about the efficacy of the activities in improving perception towards Physics. This could be done via radio, television, open forums, newsletters, internet, social media, annual reports and annual conferences as a way of sharing suggestions on how to effectively organize and utilize field trip activities among secondary schools.

5.3.3 Science Club Activities and Achievement in Physics

The study established that science club activities positively correlated with achievement in Physics. This calls for the Ministry of Education Science and Technology through the department of quality assurance and standards to enforce science club activities in all secondary schools.

5.3.4 Science Club Activities and Perception of Physics

The study established that science club activities participant's outperformed non-participants on perceptions mean scores and had a slightly strong relationship between their perceptions mean scores and achievement mean scores. As such, the government should set up science centres in the forty seven counties of the country to exhibit science experiments to learners in schools. The centres could be modelled along designs found in the western countries and should have experiments illustrating plasma ball, a black hole model, a hot-air balloon, Bernoulli blower, dynamo, transformers, characteristics and use of liquid hydrogen, circulatory system, telescopes and cathode ray oscilloscope (Aykut & Necati, 2009).

5.3.4.1 Science Congress Activities and Achievement in Physics

The study found out that science congress activities, a subset of science club activities, significantly correlated with achievement in the subject. Therefore there is need to enhance the activities is secondary schools to maximally benefit students. Ministry of education science and technology should start a "science- month" for all schools. During the event every school children be given an opportunity to listen to a popular science talk or watch a science film or exhibit, read a biography of a scientist or encouraged to make some innovations or carryout and experiments.

5.3.4.2. Science Congress Activities and Perception of Physics

The study found out that science congress activities a subset of science club activities significantly influenced students' perception towards Physics as well as relate positively with achievement in the subject. In order to maximize the benefits of science congress activities, there is need for Kenya Institute of Curriculum Development (KICD) to in co-operate the activities fully in the school syllabus as methods of teaching and learning Physics. The syllabus could suggest to the teachers how to use the activities step by step manner.

The study established that teachers highly regarded Physics non-formal activities as contributing to teaching and learning of Physics in secondary schools. In that regard, there is need to continuously train of teacher on non-formal Physics curricular activities to enable them acquaint themselves with new innovations in the area. This could be done through seminars, workshops and in-service training.

There is need for formation of Science Teacher Associations at national, county and sub-county level aimed at promoting quality teaching of science through non-formal Physics curricular activities. The associations will provide a forum for sharing research findings about integration of non-formal activities in teaching and learning among teachers, the government, media, universities, research bodies and the industry.

Teacher training Universities and Colleges should train both pre-service and in-service trainees on how to utilize non-formal science activities in their teaching. The training should focus on how the trainees can in co-operate the activities in their daily teaching since they assist in conceptualization of concepts as opposed to chalk and talk teaching approaches.

5.4 Suggestions for Further Research

Based on limitations, results and conclusions of the current study, the following are suggestions for future further research:

i. The current study looked at the influence of field trip activities on students' achievement using a group of students who were completing four years cycle of secondary education. There is need to carry out a trace study to find out whether students who go for field trip activities in secondary schools stay in science and graduate with professional related to the areas they visited while in secondary school.

ii. This study used quasi-experimental and ex-post facto design and found a significant difference between participants and non-participants on students' perception and achievement in Physics. To ascertain this result there is need for further research using quasi-experimental design involving pre- and post-test design. The research should in co-operate focus group interviews and using large population to ascertain the actual effects of field trip activities on students' perception. These researches will open up new possibilities for research on other non-formal science activities which could lead to improvement in science learning and teaching in the entire education system. Comparative studies for field trip activities with other methods of teaching Physics should be carried out to a certain effectiveness of the strategy.

iii. This study found an overall positive influence of science club activities on students' achievement in Physics, but did not demonstrate how the learning occurred. Future research should be undertaken to establish how learning occurs in the science club activities in order to test their relative contributions towards cognitive and affective changes in learners.

iv. Though science club activities were found to significantly influence students' perception towards Physics. There is to carryout studies with pre- and post-test design, associated with focus group interviews to elicit more information about the benefits of science club activities have on secondary school students.

v. There is need for undertaking longitudinal studies to establish whether participants of science congress activities end up in careers and opportunities related to science. Tracing the students after high school will help determine how their initial participation in science congress activities informed their careers choices. This will enable teacher's formulate strategic interventions for assisting more students shape their career paths by participating in the activities.

vi. Participants of science congress activities registered significantly high perception mean scores towards Physics subject as compared to non-participants. There is need for further investigation on combined influence of all the two non-formal activities on students' perception and data should be analysed using inferential statistics of chi-square and regression.

vii. This study revealed that teachers generally agreed that non-formal curricular activities contributed fully to teaching and learning of Physics, however, they also noted that some administrators do not support the activities. In view of that, this study should be replicated in other science subjects of the school curriculum so as to inform policy makers for integration of non-formal curricular activities in all subjects of the school curriculum.

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APPENDICES

APPENDIX A: Student Perception Questionnaires

Section A: Student Perception Questionnaire One (SIQ1)

PROFORMA FOR STUDENT DETAILS

School Type: Boys ☐ Girls ☐ Mixed ☐ (Tick √ only one)

Non formal Physics activities you participate in

1)………………………………………………..

2)………………………………………………..

3)………………………………………………..

Physics and Field Trips Activities Survey

Answer the following questions based on your experience in Physics. Thanks for participating in the survey.

Helpful Definitions:

Fieldtrips- Activities or project work that involves visits to industries, research centres, airports and power stations or learning that is conducted outside the physical classroom.

Class work- Assignments, activities, or experiments completed inside the classroom or laboratory.

Indicate by ticking (√) whether you strongly disagree (SD), disagree (D), undecided (U), agree (A) or strongly agree (SA) with each of these statements. Please answer all.

Statement	SD	D	U	A	SA
1)When I participate in field trips my perception of Physics improves					
2) Class work has helped me to improve my perception of Physics					
3)When I participate in field trip my perception to learn Physics improves					
4)Class work increases my perception to learn Physics					
5)I like Physics when I am involved in class work					
6)I enjoy Physics when we go for field trips					
7)I feel Physicist when we go for field trips					
8)I feel like a scientist when we learn Physics in the classroom or laboratory					
9)I understand the nature of Physics by going for field trips (how Physics and Physicists work)					
10)I understand the nature of Physics by learning in class (how Physics and Physicists work)					
11)All Physics classes should incorporate more class work					
12) All Physics classes should incorporate more field trips.					
13) I am more likely to hand in assignments when they involve field trips.					
14) I am more likely to hand in assignments when they are assigned to a class.					

Adapted from: Stephen, A. (2006)

Section B: Student Perception Questionnaire Two (SIQ2)

Physics subject and Science Club Activities Survey

Answer the following questions based on your experience in Physics subject. Thanks for participating in the survey.

Helpful Definitions:

Science club activities: These are Physics activities which are timetabled in the school and take place after classes. They mostly involve students who are perceptive in science activities and aspire to pursue Physics related courses.

Class work- Assignments, activities, or experiments completed inside the physical classroom or laboratory.

Please indicate by ticking **(√)** whether you strongly disagree (**SD**) disagree (**D**) undecided (**U**) agree (**A**) strongly agree (**SA**) with the statement given:

Statement	**SD**	**D**	**U**	**A**	**SA**
1)Science club activities have helped me to improve my perception in Physics					
2)Class work has helped me to improve my perception in Physics					
3)Science club has improved my perception to learn Physics					
4)Class work has improved my perception to learn Physics					
5)I like Physics when we learn in class					
6)I enjoy Physics when I participate in science club					
7)I feel like a Physicist when I participate in science club activities					
8)I perceive myself as Physicist when I learn Physics in the classroom or laboratory					
9)I understand the nature of Physics by participating in science club(how Physics and Physicist)					
10)I understand the nature of Physics by doing class work(how Physics and Physicist work)					
11)All Physics lessons should incorporate more classroom work					
12) All Physics lessons should incorporate more science club activities.					
13)I am more likely to hand in Physics assignments when they involve science club activities					
14) I am more likely to hand in Physics assignments when they are assigned in the classroom.					

Adapted from: Stephen, A. (2006).

Section C: Student Perception Questionnaire Three (SMQ 3)

Physics Subject and Science Congress Survey

Answer the following questions based on your experience in Physic subject. Thanks for participating in the survey.

Helpful Definitions:

Science congress: An annual science competition that involves students presenting exhibitions and talks in the field of science and applied technology.

Class work- Assignments, activities, or experiments completed inside the physical classroom or laboratory.

If YES what level did you stop in the competition?

SCHOOL ☐ ZONAL ☐ DISTRICT ☐ NATIONAL ☐

Please indicate by ticking (√) whether you strongly disagree (**SD**) disagree (**D**) undecided (**U**) agree (**A**) strongly agree (**SA**) with the statement given

Statement	**SD**	**D**	**U**	**A**	**SA**
1) Science congress has helped me to increase my perception in Physics subject.					
2) Class work has helped me to increase my perception in Physics.					
3) Science congress has increased my perception to learn Physics.					
4)Class work has increased my perception to learn Physics					
5)I like Physics when we do class work					
6)I enjoy Physics when I participate in science congress					
7)I feel like a Physicist when I participate in science congress activities					
8)I feel like a Physicist when I learn Physics in the classroom or laboratory					
9)I understand the nature of Physics by participating in science congress (how Physics and Physicists work)					
10)I understand the nature of Physics by doing class work(how Physics and Physicist work)					
11)All Physics classes should incorporate more class work					
12) All Physics classes should incorporate more science congress activities.					
13)I am more likely to hand in Physics assignments when they involve science congress activities					
14) I am more likely to hand in Physics assignments when they involve assignment in the class.					

Adapted from: Stephen, A. (2006)

APPENDIX B: Teacher Perception Questionnaires
Section A: Teacher Questionnaire One (1)

FACTORS INFLUENCING IMPLEMENTATION OF NON-FORMAL PHYSICS CURRICULAR ACTIVITIES (SCIENCE CONGRESS, FIELD TRIPS AND SCIENCE CLUB ACTIVITIES)

Gender Female [ ] Male [ ]

Teaching Experience
1 – 2 years [ ]
3 - 4 years [ ]
5 – 10 years [ ]
11 and Above [ ]

Indicate by ticking **(√)** whether you strongly disagree (**SD**), disagree (**D**), undecided (**U**), agree (**A**) or strongly agree (**SA**) with each of these problem statements. Please answer all.

Problem teachers face when preparing students for non-formal Physics activities	**SD**	**D**	**U**	**A**	**SA**
I lack sites for students to visits,					
I experience financial constrains to undertake activities ,					
I lack means of transport to take students for the activities,					
I lack time for activities					
The school schedule is tight,					
Sites of visit have restriction on number of students to visit,					
I lack knowledge to integrate activities in classroom learning					
The school administration is supportive					
National examinations lack non-formal Physics activities questions					

Section B: Teacher Perception Questionnaire (Two) 2

REASONS FOR INVOLVING STUDENTS IN FIELD TRIPS, SCIENCE CONGRESS AND SCIENCE CLUB ACTIVITIES

Indicate by ticking **(√)** whether you strongly disagree (**SD**), disagree (**D**), undecided (**U**), agree (**A**) or strongly agree (**SA**) with each of these reason statements. Please answer all.

Reason for involving students in science congress and club activities	**SD**	**D**	**U**	**A**	**SA**
The activities are relevant to class work,					
The activities are teaching tools,					
The activities improve students' perception and motivation to learn Physics					
The activities improve students' perception about the role of Physics and scientists in the society					
The activities enable students to travel to far places					
The activities broaden students' view of Physics concepts and principles					
The activities inspire students to choose Physics careers in future					
The activities enable students to compete for certificates and prizes					
The activities keep students busy in school					

Adapted from: Stephen, A. (2006).

Section C: Teacher Questionnaire (Three) 3

(Interview Schedule)

The following basic questions will be used to assess the influence of non-formal activities of science club, field trip and science congress on teaching Physics at secondary school level.

1. Do these activities influence students' learning of Physics?

2. Do the activities influence academic performance in Physics subject?

3. What are the benefits of involving secondary school learners in following non-formal teaching activities of:

   i. Field trip activities

   ii. Science club activities

   iii. Science congress activities

4. Are these activities well supported by schools administration?

5. What can be done to improve the non-formal teaching activities in secondary schools?

APPENDIX C: Physics Achievement Test (PAT)

NAME………………………………..

Time: 1HR 20MIN

Please answer the following question to the best of your knowledge.

Q1. If the pressure on a gas is doubled at the same time its absolute temperature is doubled. Calculate the change in volume of the gas. (2marks)

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Q2. In an experiment to estimate the diameter of an oil molecule, an oil drop of diameter 0.05cm spreads over a circular patch whose diameter is 20cm. Determine the diameter of the oil molecule (3marks)

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Q3. State two factors that affect the centripetal force of a body moving in circular motion

(2marks)

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Q4. A cork and a stone are both held under water and released at the same time.

(i)State the observation that would be made (1mark)

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…………………………………………………………………………………………………

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…………………………………………………………………………………………………

(ii)Explain the observation above (2marks)

…………………………………………………………………………………………………

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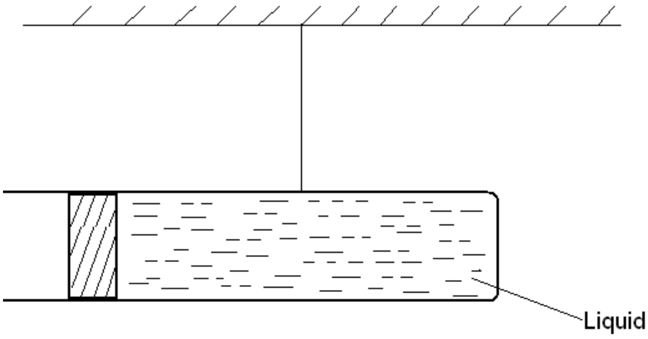
…………………………………………………………………………………………………

Q5.The figure below shows a liquid in a long cylindrical tube closed at one end with a cork. The cork is tight fitting but movable. The system is in equilibrium.



(I)State two observations that would be made when the tube is gently heated uniformly (1 mark)

…………………………………………………………………………………………………

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…………………………………………………………………………………………………

(ii)Explain your observation above. (2 marks)

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Q6. A liquid flows along a horizontal pipe of cross-sectional area $20cm^2$ with a speed of 5m/s. The speed increases to 8m/s where there is a constriction. Calculate the cross-sectional area of the constriction. (2 marks)

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Q7.State the law of conservation of linear momentum (1 mark)

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Q8.Give two reasons why the efficiency of a machine is always less than 100% (2 marks)

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Q9. Explain why bodies in circular motion undergo acceleration even when their speed is constant. (2 marks)

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Q10.A particle moving along a circular path of radius 5cm describes an arc length of 2cm every second. Determine:-

(i)Its angular velocity (2 marks)

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…………………………………………………………………………………………

(ii)Its periodic time (2marks)

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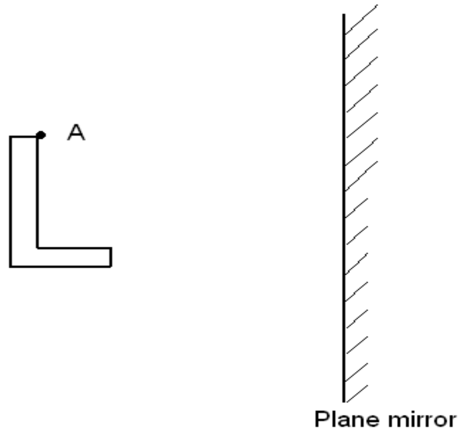
Q11.On the diagram below draw the image of the whole letter L in the mirror

(3 marks)



Q12.A soldier standing some distance from a tall building blows a whistle and hears its echo, 1.8 seconds later. How far is the wall from the soldier (speed of sound = 330m/s)

(2 marks)

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Q13.State TWO factors that affect heating effect of an electric current (2 marks)

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Q14.State the Lenz's law. (1 mark)

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Q15. Give two uses of radioactive material in Agriculture (2 marks)

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Q16. Distinguish between extrinsic and intrinsic semi-conductors (2marks)

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Q17. State two possible causes of long sightedness (2 marks)

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Q18. (a) A car drives at a velocity of $22ms^{-1}$. Suddenly the car has to break. The car covers a distance of 55m while braking. Calculate the acceleration of the car (3marks)

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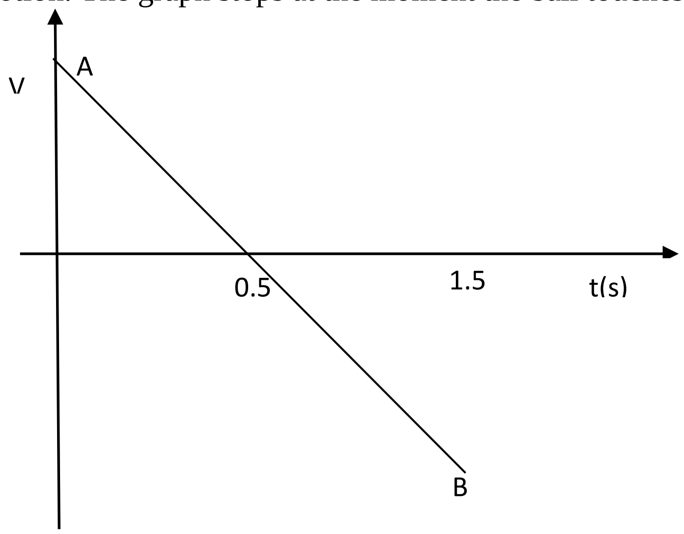
(b)A ball is thrown up and falls down again. The figure shows the v-t diagram for this motion. The graph stops at the moment the ball touches the ground (t=1.5s)



(i) Describe the motion of the ball in part A and B of the motion. (2marks)

Part A

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Part B (2marks)

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(ii)Determine the initial velocity of body (3marks)

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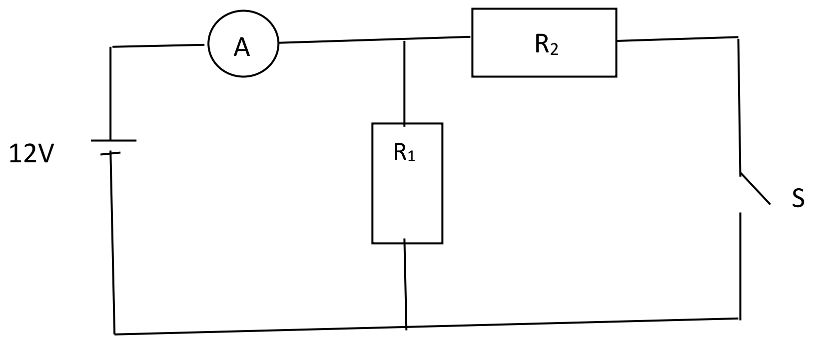
Q19. The diagram below has battery of negligible internal resistance and switch S is closed. The reading on the ammeter is 3.0A. When the switch is opened, the reading is 2.0A



Determine the value of

(i) R_1 (2marks)

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(ii) R_2 (2marks)

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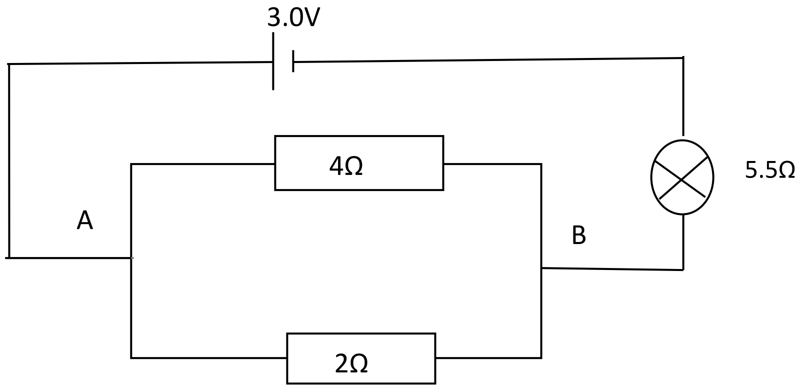
Q20.A cell has an e.m.f 3.0Vand internal resistance r. This cell forms the power supply of a circuit as shown below. The current through the 4.0 ohm resistance is 0.10A



(i)How much electrical charge passes through the 4.0 ohm resistance in 65 second? (2marks)

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(ii)What is the current through the 2.0 ohm resistance? (3marks)

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(iii) The e.m.f internal resistance r of the cell (3marks)

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APPENDIX D: Research Consent Form

Maseno University Ethics Review Committee (MUERC)

Participant Consent Form and Information

NAME OF PARTICIPANT:

Title of Research: **PERCIEVED INFLUENCE OF PARTICIPATION IN NON-FORMAL CURRICULAR ACTIVITIES ON SECONDARY SCHOOL STUDENTS' PERCEPTION AND ACHIEVEMENT IN PHYSICS IN VIHIGA COUNTY OF KENYA**

Main Investigator:

Esokomi Solomon Nuni,
PG/PHD/0036/2009
Department of Educational Communications,
Technology and Curriculum Studies
School of Education, Maseno University
P.O.Box, Private Bag Maseno, Kenya
E-mail: esonuni@yahoo.com
Cell Phone: +254720826311

I agree to take part in the above mentioned research. I have read the participant information sheet which is attached to this form. I understand what my role will be in this research, and all my questions have been answered to my satisfaction.

I understand that I am free to withdraw from the research at any time, for any reason and without prejudice.

I have been informed that the confidentiality of the information I provide will be safeguarded.

I am free to ask any questions at any time before and during the study.

I have been provided with the copy of this form and the participant information sheet.

Data Protection: I agree to the researcher processing personal data which I have supplied. I agree to the processing of such data for any purpose connected with Research Project as outlined to me. I give permission for the researcher to use and publish any data gathered.

Name of Participant ……………… Signed …………….. Date…………….

PARTICIPANT INFROMATION SHEET

Section A: The Research Project

The title for this research is: influence of participation in non-formal curricular activities on secondary school students' perception and achievement in physics in Vihiga county of Kenya.

The purpose of this study is to determine the influence of Physics non-formal curricular activities on students' perception and achievement in Physics in secondary schools in Vihiga County of Western region of Kenya. The researcher intends to investigate how field trips, science congress and club activities influence students' perception and achievement in Physics subject in Vihiga County secondary schools.

An invitation to participate is made by Esokomi Solomon Nuni who is undertaking this research as part of his Doctoral in Physics Pedagogy. The results of this study will be confidential and all participants will be anonymous. All the data will be kept securely at the home of the researcher.

For further information please contact:
Esokomi Solomon Nuni,
PG/PHD/0036/2009
Department of Educational Communications,
Technology and Curriculum Studies
School of Education, Maseno University
P.O.Box, Private Bag Maseno, Kenya
E-mail: esonuni@yahoo.com
Cell Phone: +254720826311

Section B: **YOUR PARTICIPATION IN THE RESEARCH PROJECT**

You have been invited to take part because you have relevant experience related to the research topic, for example, because you are a member of science club or a patron of science club. You are free to refuse to take part and can with draw freely at any time from the study.

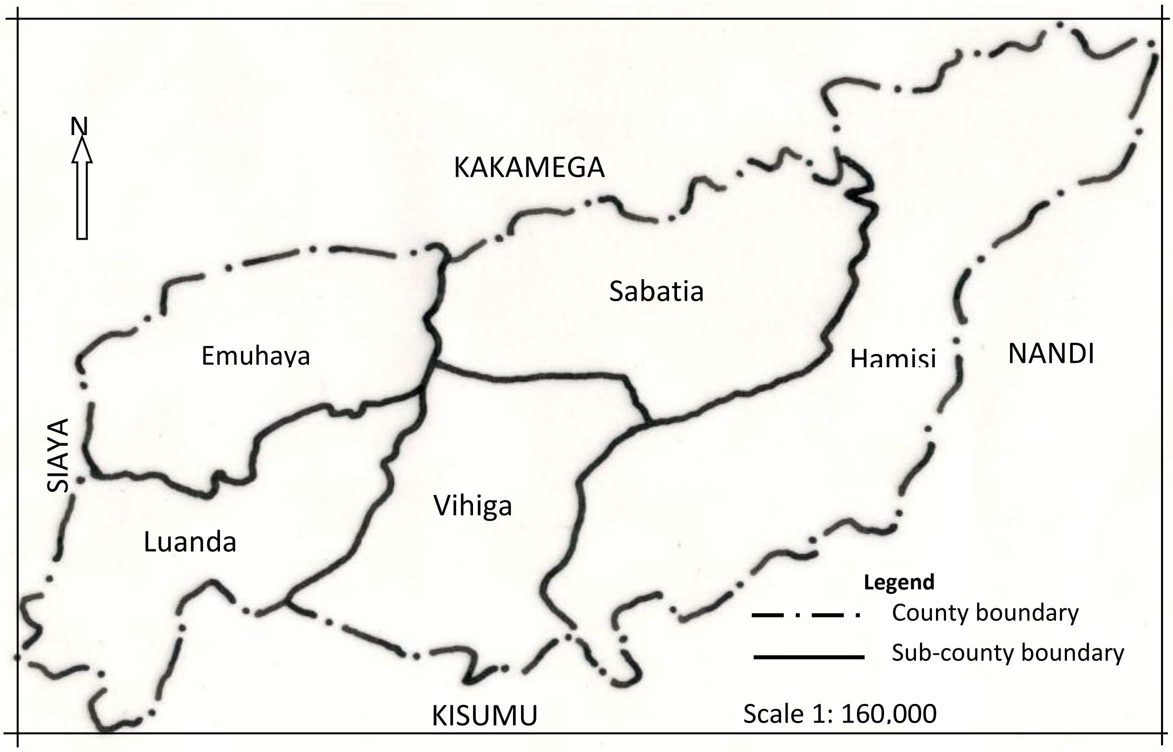
If you agree to take part you will be involved in one or more of the following methods of data collection:

1. Completion of questionnaire
2. Take part in a one on one interview
3. Answer questions on Physics Achievement Test (PAT)

There are no significant risks involved but you will be made aware of practical issues concerning the venue the event will be held. Agreement to participate in this research should not compromise your legal rights should something go wrong in the process of the research.
There will be no benefit to you for your participation in this study. However, we hope that the information generated from this study will help stakeholders in education gain more insights in the influence of non-formal curricular activities on students' perception and achievement in Physics.

Data collected during the research will be kept securely and then destroyed when the research project is completed. Your participation in will be kept anonymous and confidential as you will not be named at any stage and a code will be used to represent participants.

APPENDIX E: Map of Vihiga County of Kenya



APPENDIX F: Research Permit

MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

Tel: +254 057 351 622 Ext: 3050
Fax: +254 057 351 221

Private Bag – 40105, Maseno, Kenya
Email: muerc-secretariate@maseno.ac.ke

FROM: Secretary - MUERC

DATE: 20th June, 2018

TO: Solomon Nuni Esokomi
PG/PHD/0036/2009
Department of Educational Communication
Technology and Curriculum Studies
School of Education, Maseno University
P. O. Box, Private Bag, Maseno, Kenya

REF: MSU/DRPI/MUERC/00514/18

RE: Influence of Non-Formal Curricular Activities on Secondary School Students' Interest and Achievement in Physics in Vihiga County, Kenya. Proposal Reference Number MSU/DRPI/MUERC/00514/18

This is to inform you that the Maseno University Ethics Review Committee (MUERC) determined that the ethics issues raised at the initial review were adequately addressed in the revised proposal. Consequently, the study is granted approval for implementation effective this 20th day of June, 2018 for a period of one (1) year.

Please note that authorization to conduct this study will automatically expire on 19th June, 2019. If you plan to continue with the study beyond this date, please submit an application for continuation approval to the MUERC Secretariat by 15th May, 2019.

Approval for continuation of the study will be subject to successful submission of an annual progress report that is to reach the MUERC Secretariat by 15th May, 2019.

Please note that any unanticipated problems resulting from the conduct of this study must be reported to MUERC. You are required to submit any proposed changes to this study to MUERC for review and approval prior to initiation. Please advice MUERC when the study is completed or discontinued.

Thank you.

MASENO UNIVERSITY SECRETARY
20 JUN 2018
ETHICS REVIEW COMMITTEE

Dr. Bonuke Anyona,
Secretary,
Maseno University Ethics Review Committee

Cc. Chairman.
Maseno University Ethics Review Committee.

MASENO UNIVERSITY IS ISO 9001:2008 CERTIFIED