PERSPECTIVES ON RELEVANCE OF PHYSICS TEACHER EDUCATION PROGRAMMES IN RELATION TO PEDAGOGIC SKILLS OF STUDENT TEACHERS IN PUBLIC UNIVERSITIES IN KENYA

BY

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DECLARATION

Declaration by the Candidate

This thesis is my original work and has not been submitted to any other university or institution for award of a degree.

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DEDICATION

This work is dedicated to my late dad Peter Mukekhe Wabwire. Dad, it has taken 18 years for your dream to come true. To my children Emmanuel, Rachael and Michael, whenever I count my blessings, I always count each one of you twice.

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ABSTRACT

Public Universities in Kenya are key players in the training of physics teachers through the Bachelor of Education (Science) programme. However, the training is in need of reforms due to changes in content, educational media and technology in teaching of secondary school physics. Reviews of the programme in public universities have focused on content with little attention to methodology. Further, there is lack of coordination in key areas of training among the universities yet; secondary school instruction to be conducted by the teachers is common. Enrolment and performance are low at 26.63% and 36.43% in the Kenya Certificate of Secondary Education (KCSE) physics examinations respectively. These raise questions on whether physics teacher training equips student teachers with the requisite pedagogic skills. The purpose of this study was to establish perspectives on relevance of physics teacher education programmes in relation to pedagogic skills of student teachers in public universities in Kenya. The objectives of the study were to determine the relevance of objectives of physics teacher education programmes in relation to pedagogic skills of student teachers; to determine the relevance of content in physics teacher education programmes in relation to pedagogic skills of student teachers; to establish the relevance of methods of teaching in physics teacher education programmes in relation to pedagogic skills of student teachers and to establish the relevance of assessment strategies in physics teacher education programmes in relation to pedagogic skills of student teachers. The study was anchored on Tyler's (1949) theory of programme evaluation and descriptive survey research design was employed in the study. The population comprised 420 physics student teachers, 277 secondary school head teachers, 277 heads of physics subject and 130 physics teacher trainers. Purposive sampling technique was used to select 351 student teachers, 225 head teachers, 225 heads of physics subject and 108 teacher trainers for the study. The research instruments included questionnaires and document analysis guide which were scrutinized by experts to establish their validity and a pilot study was carried out using test-retest method. Pearson product moment correlation (r) for the instruments values were determined where the questionnaires yielded r values above the recommended threshold of 0.70. Quantitative data was analyzed using means and percentages while qualitative data was analyzed by creating thematic categories and reported as verbatim excerpts. The findings reveal that objectives of physics teacher education programmes are relevant (*MS*=3.97) to acquisition of pedagogic skills but should focus more on content in secondary school, 21st century skills, formative assessment, technology in instruction and diversity in physics classrooms. Similarly, content in physics teacher education programmes was relevant (*MS* = 3.74) to acquisition of pedagogic skills with the need to address the content in secondary school physics, use of resources, integration of information technology, enhancing of manipulative skills and improvisation. Further, methods of teaching that should be emphasised in physics teacher education programmes were interactive lecture, experimentation, use of information technology, project work and use of models to cater for students with learning disabilities, while assessment strategies that should be emphasised were question and answer approach, project work, laboratory reports, portfolio analysis, use of information technology and group assessment. The findings may be useful in enhancing physics teacher education programmes of public universities for acquisition of the requisite pedagogic skills.

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ABBREVIATIONS AND ACRONYMS

APS:	American Physical Society
B. Ed (Science):	Bachelor of Education Science
CEMASTEA:	Centre for Mathematics, Science and Technology Education in Africa
EAQC:	Europe-Africa Quality Connect
EU:	Egerton University
GoK:	Government of Kenya
IUCEA:	Inter University Council of East Africa
KCSE:	Kenya Certificate of Secondary Education
KICD:	Kenya Institute of Curriculum Development
KNEC:	Kenya National Examinations Council
KU:	Kenyatta University
MSU:	Maseno University
MMUST:	Masinde Muliro University of Science and Technology
MU:	Moi University
NCREL	North-Central Regional Educational Laboratory
PIR:	Planning and Institutional Research
PISA:	Programme for International Student Assessment
PPE:	Physics and Physics Education
SMASSE	Strengthening of Mathematics and Science in Secondary Education
TESSA:	Teacher Education in Sub-Saharan Africa
TIMSS:	Trends in International Mathematics and Science Study
TSC:	Teachers Service Commission
TTC:	The Teaching Council
UN-ICT:	United Nations Information Communications Technology
UoN:	University of Nairobi
UoT	University of Twente
USA:	United States of America

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Physics teacher education is meant to facilitate purposeful learning through the use of appropriate procedures that make graduates secure meaningful employment, and handle demands of the labour market effectively. Kalei (2016) notes that teacher training at the universities is an important enterprise because standards of education in any country depend on the quality of the teachers. The design of what knowledge, skills, attitude and behaviour teachers should be equipped with during training is necessary for the success of an education system. This is because teachers are entrusted with the task of moulding learners to the desired characteristics. Similarly, Etkina (2015) has indicated that learners' acquisition of the key knowledge, attitudes and behaviour that will be active in the society and the economy depends on the ability of the teachers. Similar sentiments are also made by the United Nations Information Communications Technology (UN- ICT, 2013) in a task force report, that training influences the extent to which teachers can embrace an education system that equips students with requisite skills for the 21st century.

The call for teacher training programmes that are responsive to the growing diversity of students in secondary school physics is high as the current students require teachers who are not only experts in their own fields, but also knowledgeable in other disciplines (Queensland College of Teachers, 2012). Similar sentiments had been made earlier by Cheng (2009) who contends that the needs in physics teacher education have shifted from effective movement of merely delivering knowledge of content, towards the global movement of consumer satisfaction, sustainable development and societal change. Moreover, as much as aligning theoretical and pedagogical academic preparations in teacher education are considered to promote meaningful and worthwhile pre-service experiences (Cheng, 2013), it is also necessary that acquisition of pedagogic skills by physics student teachers is enhanced through physics teacher education programmes. This is because such skills act as a reference to the level of competency of teachers in physics instruction (SMASSE, 2008; Boyd, Grossman, Lankford, Loeb & Wyckoff, 2009).

Similarly, Etkina (2015) has argued that preparation for everyday instruction for a physics teacher that revolves around the understanding of the physics curriculum, an understanding of what a teacher wants the students to learn in each topic and the ability of the teacher to identify resources that match the teaching philosophies are key to training of physics teachers. Teachers should also be able to develop and make use of professional records effectively in preparation, implementation and evaluation of teaching and learning (Quint, 2011). Moreover, it is important that teachers are able to ascertain that the students have actually learned through the use of appropriate assessment strategies (Etkina & Van, 2007). In contributing towards modalities of training physics teachers, Cheng (2013) has noted that the training needs vary from one cohort of teachers to the other. It also depends on the national curriculum being offered at the time. It is therefore important that perspectives on the relevance of physics teacher education programmes, in relation to pedagogic skills of student teachers is determined to facilitate improvement of the programmes.

In discussing how to strengthen the position of physics teacher education in changing times, Hilburn and Ruth (2003) noted the need to enable teachers cultivate skilled and independent-minded members of the society by equipping teachers with the right competencies, values and attitudes. Such teachers are able to stir up their students' mind other than stamp the teacher's mind upon students, enable students to see through their own eyes rather than coax students to see through the teachers' eyes and also inspire curiosity in students to make the latter want to go out into the world and search for truth other than give students definite amount of knowledge (Gibbs & Coffey, 2010). Basing on the foregoing, the success of physics instruction in secondary schools depends on the training of the teachers as done largely by the universities (McCawley, 2009). For instance, physics teachers ought to know the concepts, laws and methods of scientific enquiry. Objectives of physics teacher education programmes should therefore address the scope and adequacy of knowledge of subject matter required by student teachers for effective implementation of the secondary school physics curriculum.

Moreover, physics teacher competencies have been of concern in many countries, for instance, in the United States of America (USA), physics classrooms do not provide students with the expected benefits (Rogers, 2007). Gibbs and Coffey (2004) have argued that the sudden explosion of physics-based technologies that have created a new paradigm have not yet been absorbed by the USA education system. The required technologies have also not been incorporated into the training process of teachers. Physics classes have therefore done little to prepare high school students for rigorous programmes in tertiary institution (Freedman, 2012). This has resulted in the shortage of physics teachers in USA as few students pursue physics-related courses at the university.

Lack of knowledgeable teachers in both the grade and middle schools in USA has been a matter of concern as it has negatively affected learning outcomes at these levels (Rogers, 2007). As Freedman (2012) has observed, students in USA begin courses at the university with ideas that are mainly incompatible with correct knowledge of physics and blames these on the level of mastery of physics content during training. It is therefore important that the relevance of content in physics teacher education programmes as offered by universities is determined. However, this has not been the case with many universities because content has remained as lists of standard units and allocations of time, where little is known about its relevance in equipping the student teachers with pedagogic skills.

In Poland, faint interest in physics is widely reported in secondary schools and it is blamed on the teaching approach that widely involves textbook reading in the classrooms of which students describe as boring (Sadowska & Kaminska, 2010). Hult (2012) has equally noted that the model of instruction used in classrooms in Poland indicates failure of the teacher training process to equip physics teachers with the basic foundations in methodology. Similar observations have been reported in Brazil where the reality in classrooms is that physics is transmitted by the teacher as a set of facts, laws and data that should simply be mastered and reproduced in examinations. Moreover, the UNESCO Education report of 2012 points out that those teachers who are not equipped with a variety of methods of teaching are unable to meet learning demands of students. As a result, there is diminishing interest of students towards physics.

Ineffective approaches to teaching secondary school physics are blamed on the training process of physics teachers at the universities because graduates are reported to be unable to implement relevant strategies such experimentation, demonstration, group work and project work that are necessary to spearhead meaningful learning in secondary school physics (Sonza & Elia, 2013). Moreover, Amunga, Musasia and Musera (2011) have urged that a necessary teacher competency especially in physics is to have an understanding of the learning process, as teachers are expected to create learning environments in which students can master concepts. In universities where relevance of methods of teaching is seldom reported, it remains unclear as to whether graduates are equipped with an understanding of the key principles that guide insight into teaching secondary school physics as a whole. This is in ways such as the extent to which organisation of the learning experiences at the universities enable trainees acquire pedagogic skills needed for effective secondary school physics instruction. Equally, Darling-Hammoud (2008) has asserted that it is important for teachers to be equipped with a variety of procedures to collect information about instruction and learning.

A different scenario on the interest of students towards physics is reported in China where physics is compulsory in primary education, and the country has also recorded high enrolment of students in physics-related careers in senior secondary and university education. Chinese scholars attribute the high enrolment to the right methods of teaching used by its teachers that has enabled enrolment in physics to meet the needs of the economy and the labour market (Ren, 2002; Zhu, 2007). Huaying (2012) further notes that the right methods of teaching used by the teachers of physics in secondary schools are as a result of the process of good quality of training at the universities. This has encouraged the establishment of a strong programme in physics education, research and associated implementation of research by some international universities. For instance, according to the American Physical Society (APS), the University of Illinois is such that all members at the Department of Physics Education demonstrate their commitment to undergraduate education and they have collectively recreated the attitude of undergraduate physics students. This entails rethinking curricular content, redesigning laboratories, remodelling classrooms, incorporating innovative education technologies and drawing on the result of their nationally recognized physics education research group (APS, 2013).

Moreover, Gibbs and Coffey (2004) observe that generally, majority of the teachers simply assess their students for promotion and very little of conceptual knowledge is verified. They blame these on the training process that teachers undergo. While Oleson and Hora (2012) have argued that teachers often assess students in ways that they were taught by replicating models that were used during training, some of which however, are ineffective. Some of the universities that have endeavoured to address the issues of assessment during training include the Florida International University which has also taken wide initiatives to attract and retain students in physics-related careers (APS, 2013). In addition, the James Madison University has been exceptional for sustaining a strong teacher education effort through implementation of research based assessment during physics teacher training process. Since assessment skills of teachers are as a result of the training that the teachers underwent, it is necessary for universities endeavour to equip physics teachers with relevant assessment skills in order to achieve improved assessment procedures in secondary school physics instruction.

In Ireland, physics teacher education is practised within a policy framework that highlights the evolving and dynamic programmes for teaching and in the increasingly complex role of teachers today (TTC, 2011). In reference to this, the policy states:

> *"The time is now right for a thorough and fresh look at teacher education to ensure that tomorrows teachers are competent to meet the challenges that they face to enable them support their students' learning." (p. 7)*

This informed the development of a set of criteria and guidelines that developers of physics teacher education programmes are required to observe. The criteria require that programmes of initial teacher education should be compliant with the relevant requirements of higher education and that methods of teaching and assessment should be evident in the structure of teacher education. In light of these, all areas of study should be relevant to the trainee's future work as teachers, developing their understanding and experience of the complexity of teaching. Furthermore, the guidelines state that programme objectives of teacher education should be clearly defined and aligned to specific frameworks and should reflect specific learning outcomes.

The objectives should be tailored to equip qualified teachers with a set of competencies to facilitate quality learning and cater for national priorities. The objectives should also target to prepare student teachers for teaching, learning and assessment in secondary schools. Moreover, objectives of the training programmes should enable student teachers gain entry into their professional roles in the area of collaborative and dynamic school environment thus enabling them to engage with colleagues, co-professionals and parents and at the same time understanding their responsibilities (TTC, 2011).

Similarly, Maera (2016) has noted that content in physics teacher education should be such that it addresses foundation studies, professional studies, subject disciplines and school placement that should be taught in an integrated format. Foundation studies should comprise courses in curriculum studies, history and policy of education, philosophy of education, psychology of education, sociology of education and courses in subject discipline while professional studies to be offered include subject pedagogies. Furthermore, a range of optional courses should be offered which allow students to develop specialisation in subject disciplines (Von, 2019). Programme design should be able to allow key concepts to be revisited over the period of the course to develop deeper understanding while the cultural aspects of the citizens should be integrated in the implementation of teacher education (TTC, 2011).

In school placement programmes, communication and interpersonal skills of student teachers should be advanced and an understanding of teaching as a self-critiquing learning with opportunities for teamwork and inquiry based initiatives is necessary (Brekelmans, Brok, Tartwick & Wubbels, 2005). School placement should provide opportunities for student teachers to integrate theory and practice, develop classroom organisation, behaviour management skills and practice with the use of resource materials and Information Technology. Student teachers should also be accorded an opportunity to reflect critically on their own practice during the school placement period (TTC, 2011).

Methods of teaching in physics teacher education should be such that a variety of teaching and learning strategies are incorporated such as tutorials, small group work and experiential learning (Marcelo & Marina, 2014). While foundation studies, professional studies and subject disciplines should be carefully executed in line with the changing understanding of the nature of learning and the theory-practice relationship. There should be an appropriate balance in the programmes provisions while the inter-relations in foundation studies, professional studies and subject discipline need to be made explicit in teacher education (Couso, 2009). Moreover, Ramsey, Nemeth and Haberkon (2013) have indicated that assessment strategies in teacher education should equip the trainees with a variety of assessment techniques. Student teachers should also be accorded an opportunity to practice both formative and summative assessment alongside assessing literacy and numeracy aspects of their subject areas. Of equal importance is that teacher education should integrate research informed insights into student teachers' understanding of the practices undertaken during assessment.

In light of the above, the guidelines of physics teacher education are understood to be bound by historical, socioeconomic and cultural contexts. This is in agreement with the social constructivism school of thought which proposes that the ultimate good of education is achieved if programmes are informed by context-specific perspectives that are often constructed. The systems should therefore facilitate the interaction between the inquirer and the subjects of inquiry with the aim of sharing experiences (Lincoln & Guba, 1985; George Lucas Educational Foundation, 2015). In a learning environment, the sharing of experiences between a teacher and a learner influence what learners perceive in a particular situation. Teacher education should therefore guide trainees and enable them to understand the complex, multiple realities and perspectives of the learners at the time they are recruited to teach. The need to understand physics teacher education as a social phenomenon and in order to link training to pedagogic skills required for effective secondary school physics instruction, it is important that the relevance of the physics teacher education programmes is determined.

In Africa, Kriek and Grayson (2009) have noted that science education is a cause of concern. In South Africa for example, majority of teachers display limited content knowledge coupled with ineffective teaching approaches and unprofessional attitude. Teachers were also observed to lack confidence due to poor mastery of the concepts and phenomena in physics hence the conclusion that majority of the teachers were not prepared adequately for the job that they do. While a study done by Shongwe and Ocholla (2009) revealed that graduates at the University of Zululand suggested that they needed in-depth content imparted during training to enable them to be more confident in teaching. It was also established that most teachers lack awareness of students' forms of learning and thinking in Nigeria and that most teachers neither carry out innovations of new curricula, nor use a variety of methods of teaching (Omosewo, 2007).

In Kenya, the Europe-Africa Quality Connect evaluation report (EAQC, 2012) has raised concerns over the training programmes of physics teachers as the graduates lack the capacity to impact positively on learners' achievement and enrolment in physics. The report further challenged universities to work on modalities that would enable graduates to transform secondary school learners from being mere consumers to generators of knowledge. Similarly, a baseline survey carried out by SMASSE (2007) indicated that poor teaching methods and lack of mastery of content in physics by teachers contributed to the poor performance recorded in KCSE physics examinations. A follow up situational analysis report revealed that the practice of student-centred teaching and improvisation has been inadequately entrenched in physics instruction (CEMASTEA, 2013). Similarly, in a presentation to the Education World Forum on curriculum reform in Kenya, Jwan (2016) noted that employers feel that graduates from the school system do not have the soft skills that are crucial for moulding productive human resources. This is especially applicable to secondary school physics whose knowledge and processes form the foundation for majority of the careers.

The objectives of secondary school physics in Kenya that teacher education need to address states that, by the end of the four year course, the learner should be able to: select and use appropriate instruments to carry out measurements in the physical environment; use the knowledge acquired to discover and explain the order of the physical environment; use the acquired knowledge in the conservation and management of the environment; apply the principles of physics and acquired skills to construct appropriate scientific devices from available resources; develop capacity for critical thinking in solving problems in any situations; contribute to the technological and industrial development of the nation; appreciate and explain the role of physics in promoting health in society; observe general safety precautions in all aspects of life; acquire and demonstrate a sense of honesty and high sense integrity in all aspects of physics and life in general; acquire positive attitude towards physics and acquire adequate knowledge in physics for further education and training (Kenya Institute of Education, 2003)..

The objectives of teacher education programmes (Appendix F) should endeavour to address the objectives of secondary school physics that the graduates are expected to achieve while in employment (Hilburn & Ruth, 2003; DeMonte, 2013). Of concern is that the objectives have guided the development of content, methods of teaching and assessment strategies in physics teacher education programmes and yet, objectives of secondary school physics curriculum on applying principles of physics and acquired skills to construct scientific devices and improvisation, to build capacity for critical thinking and solving problems in all situations, to observe safety precautions in all aspects of life and to demonstrate high levels of integrity in all aspects of are inadequately entrenched in the objectives of physics teacher education programmes.

Moreover, the Kenya Institute of Curriculum Development (KICD) physics teaching syllabus outlines 40 topics to be taught is secondary school physics that are covered under mechanics, light, heat thermodynamics, electricity and magnetism, atomic physics, waves and electronics which should be equally be addressed in in the content of physics teacher education. Similarly, the use of experimentation, demonstration, group work, interactive lecture, project work alongside the use of information technology are the recommended methods of teaching in secondary school physics (KIE, 2003), while question and answer approach, written examinations, laboratory reports, peer assessment and students' self-assessment are the recommended assessment strategies to be used in secondary school physics (KNEC, 2013).

The Teachers' Performance Appraisal and Development (TPAD) tool on the other hand has outlined the teaching standards expected of a physics teacher by stating the competency areas that physics teachers should conform to (Appendix G). These standards are inadequately entrenched in the content of physics teacher education and include: the ability of the teacher to prepare to organize individualised learning to cater for all learners needs, ability to prepare teaching and learning aids, ability to improvise and use locally available resources for effective teaching and learning outcome, integrate ICT in physics instruction and assessment and also demonstrate an understanding of legal provisions in education, provide child friendly, safe and collaborative learning environment, be of high moral and ethical grounding and also, demonstrate critical thinking skills and problem solving abilities at all levels of instruction in physics.

The Education Act No. 12 of 2012 and the National Education Sector plan of 2013 – 2018 identifies the challenges in the education system in Kenya as a weak linkage between training and the labour market, inadequate integration of ICT into instruction and lack of guidelines to address cross-cutting issues that affect learning outcomes such as integration of national social values. The existing disparities between the objectives and content in physics teacher education programmes and the requirements for effective secondary school physics raises concerns on whether the physics teacher education programmes equips the student teachers with requisite pedagogic skills for effective secondary school physics instruction. Moreover, it remains unknown to whether the recommended methods of teaching and assessment strategies in secondary school physics are adequately addressed in physics teacher education programmes.

Boyd, Grossman, Lankford, Loeb and Wyckoff (2009) have observed that the only element of teacher preparation programmes that can predict how new teachers will actually teach is the experience with instruction in the first year of their teaching. The inadequacies exhibited by the physics teachers are therefore associated with the weak links between the pre-service teacher training process and the requirements for effective secondary school physics instruction (Nui & Wahome, 2006). This led to the initiation of SMASSE in-service teacher training programmes in Kenya as a mitigation measure to address the existing disconnect between the training of physics teachers and the realities in the working environment (SMASSE, 2007). Furthermore, the Teacher Education in Sub-Saharan Africa (TESSA, 2010) formative report raised several issues with the teacher training process in Kenya such as lack of a firm philosophy guiding the teacher training programmes. Of equal importance were the missing guidelines on the specific methods of teaching and assessment strategies that should be used during the process of training physics teachers (Harley & Simiyu, 2012).

Despite the concerns raised by the previous reports and researchers (CEMASTEA, 2013; EAQC, 2012; Harley & Simiyu, 2012; SMASSE, 2007; TESSA, 2010), physics teacher education programmes in public universities in Kenya has only experienced improvements guided by a standard score card where the goals of the wider B.Ed (Science) programme are evaluated in line with the mission and vision of the university. The goals of the programme are further evaluated in reference to the modes of delivery, clarity, general appropriateness and the extent to which they promote students' engagement (IUCEA, 2014; CUE, 2014).

Public universities have therefore continued to use the same course design and content adopted from the university of East Africa in 1970s, and little is known on the relevance of the programmes to acquisition of pedagogic skills by the student teachers.

Berry (2012) has noted that priority in teacher education should be given to acquisition of subject matter content because the understanding of the depth and organisation of subject matter content influence extend to which the teacher meets the demands in physics instruction. While Anwaruddin (2015) and Silva (2017) asserts that assessment skills and communication skills are key for effective delivery of physics instruction. Moreover, Etkina (2015) has argued that physics teachers require adequate knowledge and skill to utilise instructional resources effectively and teachers' skills in use of information technology facilitate effective production and sharing of physics content (Berry, 2012; Wiema, 2007). Therefore in the current study, Subject matter content, assessment skills, communication skills, skills in use of resource material and skills in use of information technology by physics teachers comprise the pedagogic skills requisite for effective secondary school physics instruction in the current study.

On the other hand, in the unveiling of a team to steer curriculum reform process at the Kenya Institute of Curriculum Development (KICD), the Ministy of Education (MoE, 2016) reiterated the urgent need for relevant and quality education at all levels. There were also calls for improvements on the training programmes of teachers for the sake of effective monitoring and evaluation of the proposed reformed curriculum. Consequently, it is important that improvements based on the demands in secondary school physics instruction and on acquisition of the requisite pedagogic skills by student teachers is incorporated.

However, public universities in Kenya have been training physics teachers using the adapted Bachelor of Education (B.Ed) Science programmes that has been passed over from the founding universities. The programmes have also had variations on the objectives, content, methods of teaching and assessment strategies, and since secondary school teachers implement a common physics curriculum and they are all expected to align to similar performance criteria, it is necessary that key provisions in physics teacher education programmes of universities are coordinated. Furthers, skills required in secondary school physics instruction are not adequately addressed in the objectives of physics teacher education programmes. Therefore, there is need for the current research to establish weather physics teacher education programmes equips student teachers with the requisite pedagogic skills for effective secondary school physics instruction. Consequently, the Teachers Service Commission (TSC) entirely depends on accreditation by universities to employ physics teachers for secondary schools (TSC, 2012) making it necessary for public universities to continually address the aspirations of the employer which have evolved over the years.

The Kenya National Examinations Council (KNEC) annual reports of the years 2008, 2010 2012 and 2016 have noted that the enrolment in secondary school physics is low with even some schools not offering physics at all. While Murei (2016) and Ng'ang'a (2018) established that peer influence, poor attitude and poor methods of teaching by subject teachers has contributed to the declining popularity of physics among students leading to low enrolment at the national level. Sentiments earlier made by Nyongesa (2014) that poor teaching methods and poor use of resources in physics instruction has resulted to low enrolment in physics. While Amadalo, Ocholla and Memba (2012), Wambugu and Changeiywo (2008) and Barrack (2014) blamed the low enrolment on poor pre-service training that produces incompetent physics teachers who hardly improve their skills during their teaching career Whereas the Kenya Institute of Education (KIE, 2003) entrenched physics in the school curriculum on the basis that knowledge of physics is useful in increasing economic productivity and for attainment of industrialisation, enrolment in physics as compared to other science subjects in the years 2007 – 2016 remains low. This is shown in Table 1.

Table 1: Enrolment Trends in the KCSE Science Examinations from 2007 – 2016 in Kenya

Year	Total Candidature	Chemistry	Biology	Physics	Physics (%)
2007	273,504	267,719	248,366	73,976	27.04
2008	311,795	255,671	281,733	82,384	26.42
2009	337,405	305,027	283,564	89,479	26.51
2010	357,488	354,092	299,302	93,698	26.21
2011	411,783	406,223	369,534	112,416	27.30
2012	436,349	427,308	386,538	118,508	27.16
2013	446,696	439,941	397,314	119,862	26.83
2014	483,630	477,536	434,203	127,049	26.27
2015	522,870	501,955	250,191	135,423	25.90
2016	577,079	547,647	488,208	154,080	26.70
		Overall			**26.63**

Source: Kenya National Examinations Council (2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016)

This low enrolment in physics is detrimental to an economy that is to be founded on physics knowledge acquired by its citizens as outlined in the Kenya Vision 2030 document (GoK, 2007). The low enrolment is coupled with poor performance in physics at KCSE level nationally over the same period. While Harley and Simiyu (2012) blame the poor performance on poor pedagogy in secondary school physics instruction, that do little to provide the needed interventions that can enable secondary school physics students realise their potential. Performance in KCSE physics examinations for the last 10 years is shown in Table 2.

Table 2: Performance in KCSE Physics Examinations from 2007 - 2016 in Kenya

Year	Mean Score in (%)
2007	40.22
2008	36.71
2009	31.33
2010	35.13
2011	33.42
2012	37.87
2013	40.10
2014	40.23
2015	40.85
2016	28.42
Overall Mean Score	**36.43**

Source: Kenya National Examinations Council (2007, 2008, 2009 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2016)

For the 10 years (2007 – 2016), performance in physics was at a mean of grade D. According to the KNEC (2011) grade D represents results that are less than standard and advices that students who attain such a grade should be assisted and made to understand what is expected of them. This grade is low given that training institutions require grade C+ for professional training in physics related courses. And as Redish (2003) has urged, students who opt for physics have got high academic self-efficacy which is a predictor of students' academic achievement. In support of Redish sentiments, Kurt, Gungor and Ekici (2014) and Tezer (2015) observe that students who have high level of self-efficacy are better at overcoming obstacles, have higher target and are more confident and it is expected that students who enrol for physics should attain good performance in KCSE examinations. Moreover, SMASSE (2008) has identified poor methods used by teachers as a major factor contribution to the inability of teachers to deliver physics instruction effectively leading to the poor performance. This is an issue to be addresses in teacher training in order to realise a system-wide effectiveness in physics instruction. These low enrolment coupled with the poor performance in physics is likely to derail the achievements of the country in future if not addressed promptly (Nui & Wahome, 2006). Of equal importance is that physics teacher education programmes should be revamped in ways that will lead to improved enrolment and achievement in secondary school physics. While Igwe (2003) has warned that any nation that does not have a strong scientific and technological base rooted in acquisition of satisfactory physics knowledge and skills, normally cannot develop its natural resources and remains permanently impoverished.

1.2 Statement of the Problem

Public universities in Kenya have conducted reviews on the wider (B. Ed) Science programmes in line with the mission and vision of the individual universities, and also, in relation to clarity, general appropriateness and the extent to which the programmes promote students engagement. Each university is known to implement its training based on individual mandates enshrined in their respective charters, but it appears that physics teacher education programmes in public universities are yet to adequately impart pedagogic skills requisite for effective instruction. Of concern is that key objectives in secondary school physics are yet to be adequately addressed in the objectives of physics teacher education programmes yet, the objectives form the basis upon which the course content, methods of teaching and assessment strategies are anchored. This is at the backdrop of the challenges facing the education sector in Kenya specifically, on the existing weak link between training of teachers and requirement in job market (Education Act No. 12 of 2012; The National Education Sector Plan, 2013). The fact that knowledge is dynamic, and so knowledge about physics pedagogy needs to evolve new approaches that are in line with the new trends in secondary school instruction. Moreover, low enrolment and poor performance in physics at KCSE level has been reported and blamed on poor methods of teaching that emanates from the training at the universities that that teachers underwent. Evidently, disparities in the objectives upon which content and methods of teaching in secondary school physics and that in physics teacher education programmes may have contributed to the observations that physics teacher graduates from public universities lack the relevant skills necessary for effective instruction. This raised the urgent need for guidelines on development of objectives, content, methods of teaching and assessment strategies in physics teacher education by public universities, and at the same time, improvements are required on the existing physics teacher education programmes particularly on the need to address the demands in the current physics classrooms. The question to be addressed by this research was what should comprise physics teacher education programmes in relation to pedagogic skills needed by student teachers for effective secondary school physics instruction?

1.3 Purpose of the Study

The purpose of this study was to establish perspectives on relevance of physics teacher education programmes in relation to pedagogic skills of student teachers in public universities in Kenya.

1.4 Objectives of the Study

Objectives of the study were:

1. To determine the relevance of objectives of physics teacher education programmes in relation to pedagogic skills of student teachers.
2. To determine the relevance of content in physics teacher education programmes in relation to pedagogic skills of student teachers.
3. To establish the relevance of methods of teaching in physics teacher education programmes in relation to pedagogic skills of student teachers.
4. To establish the relevance of assessment strategies in physics teacher education programmes in relation to pedagogic skills of student teachers.

1.5 Research Questions

The study sought to answer the following research questions:

1. What is the relevance of objectives of physics teacher education programmes in relation to pedagogic skills of student teachers?
2. What is the relevance of content in physics teacher education programmes in relation to pedagogic skills of student teachers?
3. To what extent are methods of teaching in physics teacher education programmes relevant in relation to pedagogic skills of student teachers?

4. To what extent are assessment strategies in physics teacher education programmes relevant in relation to pedagogic skills of student teachers?

1.6 Scope of the Study

The scope of the study was to determining the relevance of the objectives and content in training programmes for physics in relation to pedagogic skills needed for effective secondary school physics instruction. The amalgamated physics education programme (Appendix , F 1) used in the current study comprise of objectives, content , methods of teaching and assessment strategies formulated from the physics teacher education programmes of the sampled universities. The use of the amalgamated programme alongside constant reference to documentary evidence enabled the researcher bridge disparities that existed in the training programmes (Appendix F 3). Respondents in the study included students of B.Ed (Science) specifically physics from public universities who had one month out of three left to complete their teaching practice. This was because it was deemed that student teachers had sufficient exposure to instruction in secondary school physics that would enable them to check their experiences against their training at the university. Secondary school head teachers, heads of physics subject in secondary schools where the student teachers were undertaking their teaching practice and physics teacher trainers participated in the study.

1.7 Limitations of the Study

1. The limitations of the study were that student teachers who participated in the study taught for only one school term (Period of 3 months) and may not have had an opportunity to interact with the entire secondary school physics syllabus.

2. The use of purposive sampling technique may have impeded the researcher's ability to generalise the findings of the study to all the training programmes offered by public universities.

1.8 Assumptions of the Study

The study was based on the following assumptions:

1. That student teachers gave an honest account of the education that they received while at their respective public universities and that student teachers had undertaken training in information technology.
2. That physics student teachers in public universities attended all the scheduled learning sessions at their respective universities including teaching practice.
3. That during the teaching practice, student teachers had access to resources that enhance their pedagogic competencies and that the working environment was supportive to physics instruction.

1.9 Significance of the Study

The overall outcome of this research is to recommend what should entail physics teacher education programmes for acquisition of pedagogic skills needed for effective secondary school instruction. Specifically, the results are significant as follows:

1. The findings may generate the impetus for public universities to review their physics teacher education programmes in terms of design and content. More so, in line with the school of thought that calls for construction of physics knowledge.
2. Findings may contribute positively to the physics teachers' pedagogic competencies on the need to emphasis the use of inquiry based approaches in physics teacher education and in secondary school physics instruction.

3. Secondary school students will be the greatest beneficiaries of the study as improved pedagogy may lead to improved enrolment and achievement in physics.

1.10 Theoretical Framework

Several models have been used to evaluate education programmes and key among them include Stake's (1975) responsive model that place emphasis on the need to establish the concerns of the primary stakeholders, the Stufflebeam's (1985) Context, Input, Process, Output (CIPP) model whose framework include context evaluation to help develop goals, input evaluation to help shape views, process evaluation to guide implementation and product evaluation to serve recycling decision. Moreover, Scriven's (1972) goal free model retaliates that stated program goals should be withheld from the evaluator, as proponents of the model belief that the goals of the project may influence the evaluation process, while the Kirkpatrick's (1958) evaluation model seeks to establish the effectiveness of a training program at the levels of reaction, learning, behaviour and results.

The current study was based on Tyler (1949) objective centred theory because it is effective in evaluation and review of programmes which have clear and stable objectives during the implementation process such as the physics teacher education programmes. Tylers' theory also allows for the matching of the objectives, content, methods of teaching and assessment strategies in an educational programmes which the current study purposed to achieve. The theory provided a framework onto which matching of pre-behavioural objectives in physics teacher education programmes with actual outcomes in secondary school physics instruction as conducted by the student teachers was done. There was also the need to determine the degree to which the objectives in physics teacher education programmes are achieved and therefore, the model provided a platform upon which expectations that inform the development of objectives is matched with outcomes. Further, Tyler's (1949) theory advocates for the objectives to emanate from the students, contemporary society and subject matter specialists for the purpose of making appropriate decisions on a programme. Objectives should also be subjected to philosophical and psychological screens before being actualised and this is what the current research sought to attain. This was through collecting data from the student teachers who the training program is meant to address their instructional need, head teachers and heads of physics subject who represent the aspirations of the employer of physics teachers, and from the physics teacher trainers who provided the needed opinion of experts.

Tyler's (1949) theory recommends for a clear definition of the programme objectives and listing of situations which give opportunities for the expression of the behaviour. This should be followed by the construction of evaluation instruments that have well defined units to be used to summarise or appraise the behaviour. In addition, results of the evaluation should indicate the strengths and weaknesses of the programme, while the data collected should be examined further to give possible explanations of the patterns presented by the results. Tyler further argues that gaps in the instructional programme under evaluation need to be identified and appraisal to the training institutions on the effectiveness of attaining important objectives made.

On the basis of the foregoing, Shaaban (2014) states that the objectives should envisage the programme content intended to meet the defined learning activities. The methods that are essential in organizing of learning activities to aid in the attainment of the defined objectives should equally be well stated. Cronbach (1964) in discussing Tyler's theory urged that evaluation is essential for purposes of course improvement and should go beyond highlighting whether the course is effective or ineffective. Because of the multidimensional nature of the outcomes during instruction, evaluation should also involve the mapping out of effects of the course. In agreement with Tyler's theory, Freeman (2004) identifies the existence of tensions in the implementation of a programme and advocates for dynamism as a mechanism of addressing the tensions. Similarly, Posner's (1992) interpretation of Tyler's approach to evaluation highlights the need to establish alignment of programme objectives at levels of interdependence. He further asserts that there should be consistency between the objectives and the research instruments that will be employed in the evaluation process.

Responses on both open ended and Likert-type questionnaire items on the relevance of objectives and content in physics teacher education programmes in relation to pedagogic skills of student teachers were collected. This was done during the last month of teaching practice for the physics student teachers in line with Tyler's (1949) assertions that in order to have some estimates of performance, there is need for follow up studies on engagements in the environment of practice. At the same time, it was deemed that student teachers had sufficient exposure to instructional experiences in secondary school physics that enabled them to check the experiences against their training at the universities. Head teachers in secondary schools and heads of physics subject participated in the study to provide views of teacher' employer while physics teacher trainers were relied upon to provide expert views in physics teacher education. On the other hand, Huang and Young (2004) have criticised the use of Tylers' (1949) theory on the basis that the model does not provide feedback mechanisms to tell the stakeholders on how to deal with improvements on a programme. To overcome these weakness, items on improvements to be made on the training programmes of physics teachers was included on the questionnaires used in the current study.

1.11. Operational Definition of Terms

Assessment Skills: Ability to measure students learning during teaching and to report on the progress of learning achieved in physics instruction

Assessment Strategies: include use of any of the following assessment methods in physics instruction: group work, laboratory reports, peer assessment, end of topic quizzes, portfolio analysis, question and answer approach, project work, standard examinations, students self-assessment and use of information technology.

Communication skills: Ability to listen, talk, write, collaborate and work with others effectively and appropriately in a joint intellectual effort.

Content in physics teacher education programmes: Include courses taught to physics teacher trainees in public universities.

Evaluation: Careful thought out and measured opinion on aspects of physics teacher education programmes

Methods of Teaching in physics: Organization of educational experiences with a focus on instructional strategies, educational media, resource utilization and use of educational technology.

Objectives of physics teacher education programmes: comprises of amalgamated objectives of B.Ed Science (Physics) as offered by public universities in Kenya.

Pedagogic Skills: Teaching demands involving engagements and achievements expected of a physics teacher that reflects the level of the teacher's effectiveness and competency. They include; knowledge of subject matter, assessment skills, communication skills, skills in use of resource material and skills in use of Information Technology

Perspectives: These includes perceptions particularly on the relevance of the aspects of physics teacher education programmes

Physics Student Teachers: B. Ed (Science) in physics trainees in public universities in Kenya with one month out of three left to complete their teaching practice

Physics Teacher Trainers: Lecturers in public universities who train secondary school physics teachers in both physics content and professional areas.

Physics Teacher education: Refers to the subject content, professional and IT courses offered during the training of physics teachers by the schools of Physics, Education, Human Resource and Development, Computer and IT in public universities.

Physics Teacher Education Programmes: Refers to all courses offered to physics teacher trainees in public universities in Kenya

Public Universities in Kenya: Universities established by the government of Kenya by 2007 and accredited in 2013 that train secondary school physics teachers particularly the University of Nairobi, Moi, Kenyatta, Egerton, Maseno and Masinde Muliro University of Science and Technology.

Relevance: Close connection between aspects of physics teacher education programmes and secondary school physics

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter critically outlines the existing perspectives on objectives, content, methods of teaching and assessment strategies in physics teacher education programmes in relation to pedagogic skills of the physics teachers. The review is also borrowed from studies conducted on chemistry and biology teaching because of the shared principles and approaches common to the science subjects. The literature is organized according to the objectives of the study.

2.2 Objectives of Physics Teacher Education Programmes in Public Universities in Relation to Pedagogic Skills of Student Teachers

Objectives of physics teacher education should outline course work and activities that contribute to teacher quality and thereafter achievement of secondary school students in physics (Rice, 2003; Goe, 2007; Wayne & Youngs, 2003). On addressing the need for high quality teachers in the secondary school classroom, DeMonte (2013) has urged that physics teachers should align to set goals of the curriculum focus on delivering content and modeling of teaching strategies in the process of instruction. Buckingham and Nicholas (2013) have equally discussed that a critical component in the objectives of teacher preparation is being enabled to learn by doing. There have been several attempts at cataloguing the objectives of physics teacher education programmes such as the development of the cognitive processes, social adaptation and reconstruction, academic rationalism, personal relevance among others (Tomi, 2012). However, few researches on evaluation of objectives of physics teacher education programmes by universities have been documented.

A closer attempt at determining the relevance of the objectives of physics teacher education was made by Nivalainen, Asikainen and Hirvonen (2013), who conducted a study to explore views of pre-service physics teachers concerning the objectives of practical work at the university and in secondary schools. A sample of 32 pre-service physics teachers from the University of Eastern Finland were recruited to participate in the study. The teachers were asked to write a reflective essay about their experiences in practical work both in secondary schools which they attended as students and at the university where they were trained. This was to answer to the research question that, what objectives do pre-service physics teachers express for practical work when reflecting on their previous experiences of practical work.

Content analysis was used in the interpretation of data and it was revealed that objectives of practical work included: developing practical or experimental skills, developing an understanding of science and conceptual understanding, fostering motivation, developing an understanding of the nature of science and scientific processes and also, for enhancing of social and learning skills, with the most frequently raised objective having been the need to connect theory to practice. It was concluded that pre-service physics teachers should be offered an opportunity to reflect in their previous experiences and to put in practice the advantages of practical work (Nivalainen et al., 2013). These findings were similar to assertions made by Etkina, Murthy and Zon (2006) and Tomi (2012) that objectives of pre-service teacher education should aim at addressing knowledge and skills required for effective practice

In a separate study, the most prevalent needs of secondary school physics teachers that should be addressed by the objectives of physics teacher education were sought in Malaysia (Kamisah, Lilia and Subahan, 2006). The population of the study comprised practising science teachers in all secondary schools and stratified random sampling was used to identify

390 respondents to participate in the study. Sampling involved taking into consideration factors such as gender, geographical location of schools and the respondents' area of specialization. In the study (Kamisah et al., 2006), the needs analysis instrument was developed from the science teachers' inventory of needs (Zerub & Rubba, 1983). The final instrument was validated by having teachers and lecturers review the item with respect to its clarity and ease of responses. Suggestions were made for the improvement of the questionnaire items. The questionnaires finally comprised two sections with the first section dwelling on demographic characteristics of the respondents while the second section consisted of items on management of lessons, evaluation of students, pedagogical knowledge and skills, managing science facilities and utilities including multimedia technology and use of English language in science instruction that were put on a three point Likert scale. Reliability of the needs instrument was established by employing the internal consistency approach where the cronbach alpha values were found to range from .674 to .953 of the categories of items in the questionnaire.

Findings of the questionnaire revealed that there was no significant association between the perceived needs of gender and science teachers. This meant that the perceived needs of female teachers were similar to those of their male counterparts. However, the school location and area of specialization were found to have a significant association with the needs of physics teachers. Similarly, the results of the descriptive analysis demonstrated that the most prevalent needs of the Malaysian secondary school physics teachers that should be addressed in the objectives of physics teacher education was integration of multimedia in teaching and the challenges associated with the use of English as a language of instruction. Another important feature that emerged from this study was that teachers were highly concerned about the need for self-improvement in order to make their lessons meaningful and attractive. This indicated the deficiency exhibited by teachers in the areas of classroom instruction which is as a result of the training process that they had undertaken.

The link between the experiences of pre-service physics teachers in relation to the objectives of practical work was established in the research conducted by Nivalainen, Asikainen and Hirvonen (2013) as discussed above. This is adapted in the current research where the link between the objectives of teacher education programmes and experiences of physics student teachers were established. The adaption was informed by the existing differences between physics teacher education programmes in Finland and Kenya as the universities in Finland are responsible for the design and implementation of the 3 year period physics teacher education curriculum. Further, physics teacher education in Finland is fully subsidised by the government, while a different scenario exists in Kenya where the physics teacher training programmes takes 4 years and there is sharing of costs between the students and the government. Moreover, the existing differences between university education in Finland and Kenya created the need for a similar study to be conducted in Kenya. This was to establish the similarities and differences that may exist between the findings by Nivalainen *et al*. and findings of the current study. Moreover, reflective essays were used as the only source of data in the study done by Nivalainen et al. that may have limited triangulation of findings and also, reflective essays may have led to soliciting of vague responses especially from respondents who experience challenges in reflective writing.

Similarly, research conducted by Kamisah, Lilia and Subahan (2006) informed the focus on the objectives of the physics teacher training programmes and on the need to use purposive sampling technique in the current research. This was especially on the need to use the total population sampling in order to allow the entire population of physics student teachers on teaching practice to participate. The use of media and technology alongside English as a language of instruction which is a second language to both the teachers and students were found to be of concern to the teachers in the study conducted by Kamisah et al. A similar situation exists in Kenya which made it necessary to evaluate the extent to which communication skills of physics student teachers are addressed in the objectives of physics teacher education programmes. In addition, data was collected from practising physics teachers yet little was mentioned on their teaching experiences and in-service training received prior to the research. Since experience and in-service training is likely to impact the findings, it was necessary for a separate study with pre-service teachers and this is what the current research endeavoured to address.

Moreover, the World Bank report of (2007) notes that content taught in science in schools, physics included is largely academic and in most instances found to be irrelevant. In Kenya one of the key challenges in the education sector as identified by the National education sector plan 2013 - 2018 is the weak teacher training programmes. As Berry (2012) has assertion, weak education programmes require to review their content and that priority in teacher education should be given to subject matter content. This is because, the understanding of the depth and organisation of content influence the level to which teacher meets institutional demands in physics instruction. For these reasons which objectives of physics teacher education programmes in public universities should endeavour to address subject matter knowledge.

Teachers are primarily responsible for evaluating student learning and therefore there is need for teachers to acquire skills that can improve on the quality of physics instruction. Schaff (2006) in a study designed to report on personal assessment practices of teachers in Illinois, established that items on aggregation, scoring and interpreting of assessment result and using assessment results to make a decision were the item easily approved by the teacher, while item related to choosing the right assessment methods and development of a valid assessment procedures to be used in physics classrooms were the most difficult item for the teachers. Therefore, assessment procedures used in physics classrooms should not only measure progress in learning of content, but also endeavour to enhance higher levels of learning and achievement. In the current research, assessment skills acquired by student teacher has been identified as key to effective physics instruction hence part of the pedagogic skills that of physics teacher education programmes need to address, more so, in the objectives of the training.

A longitudinal research that traced science teachers on their skills in information retrieval, listening and observation and presentation of information (Levy, Elylon, & Scherz, 2006) concluded that communication abilities of teachers influenced teachers' beliefs, attitudes, intentions and practices. Silver (2017) has equally noted that physics teachers need to have acquired a set of communication skills that enable them deliver content effectively and also manage interactions within the classroom. Therefore, objectives of physics teacher education programmes as offered by public universities should endeavour to impart communication skills as a key pedagogic component requisite for effective secondary school physics instruction.

Further, Jarosievitz (2017) has argued that physics as a subject is activity oriented and the methods to be used for teaching require extensive use of teaching and learning resources. A survey carried out in Kenya on status of physics teaching and learning in secondary schools revealed that teachers hardly used project work in their teaching (okere, 2000). This was further attributed to the teachers' inability to utilise the available resources effectively. This led to a follow up study by Muriithi, Gunga, Ngesa, Atieno and Wachira (2013) that investigated the usage of project work by physics teachers and subsequent impact on learners' achievement in physics. The research by Muriithi et al. established that project work enhance the learning of physics and recommended for review in physics teacher training component so as to encompass project method as an alternative teaching strategy. Aina (2012) had also asserted that resource materials help teachers to meet individual differences of learners and supplements verbal explanations of concept hence the need for use of project work with a focus on use of available resources.

Moreover, the major aim of teacher education is to develop a reflective practitioner such that the thoughts, actions and practices of the teacher are focussed to enhancement of professional practices and effective use of resources (Shulman, 1987). As Eilam (2003) has contributed to Shulman's stance, acquisition of skills in use of resources in physics can be better achieved if emphasis would shift from demonstrating the application of the skills towards explicitly exposing skills on project development in learning physics and the necessary cognitive operation. Therefore, in the current research, acquisition of skills in selection and use of resource materials was one of the pedagogic skills requisite for effective secondary school physics instruction.

In the current world of rapid science and technological change, science educators have begun to see their role as preparing teachers and students alike, such that physics teachers understand and apply accepted practices of science to help students develop knowledge based on observation and experience (PISA, 2003). This involves the appropriate use of learning cycles and institutional practices such as discovery learning, interactive lecture, demonstration inquiring laboratories and hypothetical inquiry (Onasanya, Adegbija, Olumorin & Daramola, 2008). Physics teachers should equally assess students learning continually by effectively using diagnostic formative and summative practices which can be achieved best when information technology is utilised (Anwaruddin, 2015). This is because information technology has permitted all the sphere of human life including most educational undertakings and therefore, the use of the technology in physics instruction is key to construction of knowledge. Teachers' skills in use of information technology also enables the delivery of physics content effectively and therefore, skills in use of information technology by student teachers forms part of the pedagogic skills required for effective secondary school physics instruction in the current study.

2.3 Content in Physics Teacher Education Programmes in Public Universities in Relation Pedagogic Skills of Student Teachers

Antriman (2010) conducted a study that aimed at assessing the content in secondary school physics programmes in the Philippines through a survey. A sample of 464 schools classified as private, public, urban and rural schools with 767 physics teachers were selected to participate in the study. Questionnaires were used as instruments of collecting data while percentages and descriptive statistics were used in data analysis. It was revealed that academic qualification deficiency and low continuing professional involvement were the major teacher related indicators that affect secondary school physics instruction. Furthermore, teachers in private schools and in urban schools reported a higher percentage of use of technology at 93% while rural schools reported use of technology at 15%. Similar observations were made with the distribution of qualified teachers where the urban schools had 39% of qualified teachers while the rural schools had 24% of the qualified teachers. When the teachers were asked to rate their confidence on a scale of 1 to 5 where 5 is the highest confidence level in a given physics area, teachers considered themselves strong in mechanics at 3.8 with a standard deviation of .9 and weakest in modern physics at 3.0 with a standard deviation of .9. It was recommended that training of physics teachers should focus more on content. Furthermore, teachers should not be put merely into a listening mode during training but they should participate actively in the training sessions and perform hands on activities. Suggestions were put forward to incorporate views of the trainees in developing the content to be taught during training in order to improve on the motivation of the trainees.

A similar study sought to identify the problems associated with studying physics in secondary schools (Boyo, 2010) in which a sample was drawn from all the first and second year senior secondary school students in Ojo. This is within the local government area of Lagos State in Nigeria. The researcher equally recruited undergraduate students in the department of physics from the Lagos State University in Ojo to participate in the study. Questionnaires for secondary school physics students and for physics undergraduate students were used to collect data that enabled the researcher answer the research question. The study identified the inability of the teachers to impart the subject to the students as the major challenge in studying physics at secondary school level. It was further revealed that many teachers emerge from training without functional understanding of some elementary but fundamental concepts in physics. The problems experienced by secondary school physics students in Ojo were therefore blamed on the teachers' unsatisfactory qualification and effectiveness. A strong link between the challenges encountered in physics content by secondary school physics students and the university undergraduate physics education trainees was noted and it revealed the interdependency of the two levels of learning.

Moreover, in a study that sought to identify the areas that teachers and students considered as difficult in the Kenyan physics curriculum and what accounts for this difficulty, Murei (2012) sampled 75 students and 9 teachers drawn from different secondary school by use of stratified random sampling technique. Further, descriptive survey research design was used in the study and questionnaires which carried topics taught in physics syllabus from form 1 to form 4 was used to gather data. This was on a five point likert sale ranging from very easy to very difficult and was followed by personal interview between researcher and the teachers. It was revealed that 55% of the students considered physics as a difficult subject with 19% of the students indicating that they could like to pursue physics related curses in tertiary institutions of learning. Moreover the most difficult topics in secondary physics were found to be pressure, electrostatics, magnetic effect of an electronic current, moments, circular motion and floating and sinking. In total, student and teachers considered 25 out of 40 topics in the secondary school physics syllabus as difficult.

The researches discussed above (Antriman, 2010; Boyo, 2010 & Murei, 2012) recommended that content is key to the training of physics teachers and it is from this recommendation that the second objective of the current study was crystallised. Moreover, the rating of the relevance of content in physics teacher education programmes on a five point Likert scale in the current study was borrowed from the study conducted by Antriman and Murei. This was in an effort to establish the relevance of the content in physics teacher education programmes in relation to pedagogic skills needed for effective secondary school physics instruction. However, unlike in the research done by Antriman in which questionnaires were solely used in collecting data, and in the research done by Murei in which questionnaires and interview schedules were used to gather data, the current research endeavoured to include documentary evidence in order to enrich the research findings.

Equally, little was documented on how the validity and reliability of the instruments used in data collection was arrived at in the research done by Boyo (2010). These necessitated a similar research in which validity and reliability of data collecting instruments was to be determined. In the current research, expert opinion was sought in validating the instrument while reliability of the instruments was assessed after piloting of the instruments. Moreover, unlike in the study done by Boyo (2010) where only qualitative approaches were used, the current research utilised both quantitative and qualitative approaches to make a contribution towards the existing literature.

2.4 Methods of Teaching in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

Methods of teaching commonly employed during the training of physics teachers has for a long time been traditional lecture (Cassandra, 2014). Students however, achieve higher learning gains during physics instruction when interactive techniques are used (Sharma, 2017). Unfortunately, as Cassandra has further noted, it is difficult for future teachers to envision interactive learning of physics because their experience as students in secondary schools and during training has been dominated by traditional lecture method. Oleson and Hora (2012) on their part, have argued that knowledge explosion has significantly challenged the traditional model of instruction where the teacher is the expert who delivers physics content to dependent students. It is therefore important that training prepares physics teachers on how to teach in the 21st century and be able to address the evident crisis of secondary school students developing increasingly negative attitude towards physics (Vosniadou, 2009).

In a research done to establish the importance of preparedness and classroom experience as factors that are involved in the development and maintenance of teachers' self-efficacy (Gillao & Little, 2003), a sample of 54 primary education teachers and 25 student teachers in their final year of primary education training were recruited from state schools in Melbourne to participate in the study. The Emmer and Hickman (1991) questionnaire was used to collect information on various forms of classroom interaction and how they are addressed. Cain's and Brown (1996) prep-com questionnaire was adopted in the study to collect information on how the teachers perceived their training. The areas covered in teacher preparation included; general teaching, teaching theory, special needs in teaching and behaviour management. Data was collected and analyzed on a group basis using descriptive statistics, multivariate statistics and correlation analyses were conducted to assess the significance of the relationships between teachers' preparation and their self-efficacy. Findings of the study revealed that both graduate and student teachers reported that they were moderately prepared in methodology with 83.5% of the total sample indicating that they would prefer additional training. Graduates and student teachers also rated their preparation and training as not sufficient as they reported lack of the necessary strategies that always make them feel inadequate in their teaching.

In a separate study, Sajjad (2010) sought to determine the effectiveness of various teaching methods used for teaching students at graduate level. In the study, a sample of 220 graduates from the University of Karachi in Pakistan was selected using purposive sampling technique.

The objectives of the study included exploring the opinion of students about the teaching methods they perceived as the most interesting and to provide suggestion for improving quality of teaching in the light of students' suggestions. Rating of various teaching methods was done on a 5 point Likert scale with 1 being least interesting and 5 being the most interesting teaching method. It was established that the lecture method was rated as the best teaching method. The reasons given for the lecture method being the best teaching method were that the lecture method creates new ideas, serves a large class and a teacher who has mastery of the subject can explain all points and answer all questions raised by students. However, weaknesses of the lecture method were also identified and techniques of improving it were suggested as the use of stimulating and thought provoking lecture materials, use of examples and questions throughout the lecture, need to incorporate visual support in order to reinforce learning and the need for the teacher to obtain continuous feedback from learners.

In Kenya, Muriithi and Kyalo (2018) conducted a study that sought to determine the relationship between teacher characteristics and the level of usage of project method in teaching physics. Stratified random sampling technique was used to select 12 teachers in 7 out of the 8 former provinces in Kenya basing on their performance in KCSE physics examination. The focus of this study was on use of project method of teaching in secondary school physics. This is because project work had been cited as a key method in physics instruction because it is learner centred, and also, very effective in enabling learners acquire scientific knowledge and skills. It was established that teachers who have acquired high level of pedagogical skills used project method more often in teaching physics than those with low levels of pedagogical skills.

The findings by Muriithi and Kyalo were found to be similar to assertion by Wayne and Young (2011) that there is a correlation between teacher characteristics and approaches used in teaching. The secondary school physics syllabus in Kenyan education system identifies specific projects to be undertaken by students implying that teachers should employ project methods in teaching. Similarly in a research to determine the influence of teachers professional qualification on the use of experiments in teaching physics (Owour, 2015), it was established that teaching approaches used in physics affects students achievement and further revealed that most teachers of physics in Kenya had adopted lecture approaches to teach in secondary school leading to poor mastery of the content.

In Nigeria, Utib-Abasi (2011) conducted a study that sought to investigate the status and use of material resources for teaching and learning of physics in Akwa Ibom state secondary schools. The study further sought to establish how often available resource materials are used in teaching and learning of physics in the schools. The design used in the study was descriptive survey while a population of the 243 senior secondary three physics student from 120 secondary schools were recruited for the study. The researcher developed 60 items in a questionnaire on a 4-point Likert scale that was used to collect data from the respondents. Validity of the questionnaire was determined through as the items were scrutinised and improved upon by experts in the area of study, while reliability of the questionnaire was determined after piloting it on a sample of fifty senior secondary three physics students. The reliability of the instrument was calculated using Cronbach Alpha and a value of .76 was obtained.

From the analysis of the data, it was discovered that most resource material were available and adequate while a few were not. However, usage of the resources particularly the physics laboratory material was wanting, as a mean of 2.20 was obtained for their usage which is below the average of 2.50 out of 5. The inference here was that if physics laboratory resources are not averagely used for physics instructions, then learners are not prepared to acquire the knowledge skills and attitudes that are expected. These observations were in agreement with the finding by Ifeakor (2005), who observed that some physics laboratories in Nigeria are opened only on national examination days. This led to the question of whether physics teachers are equipped with appropriate skills in utilization of resources during their training process.

Findings from these researches (Gillao & Little, 2003; Sajjad, 2010; Muriithi & Kyalo, 2018; Owour, 2015; Utib – Abasi, 2011) contribute to the focus on methods of teaching by the current study because researches highlighted the need for teacher training institutions to focus on use project work in physics instruction and also on use of resource materials. However, since the sample for the research done by Gillao and Little was drawn from a population restricted to specific areas of Melbourne, findings could only be generalized to the wider population with caution. This required that a similar study be conducted with student teachers who have taught in different administrative, geographical and cultural setups in order to draw inference to varied instructional set ups. This is what the current research endeavored to attain.

Findings of the current study also reflect aspirations of the employers that physics teacher education programmes should endeavor to address. Similarly, recommendations in the study conducted by Sajjad (2010) on teaching methods used in the training of teachers were based purely on perceptions of graduates. This may have resulted in findings that are subjective because views of other key stakeholders in teacher education such as the experts were not represented. This created the need for a follow up study that will incorporate the views of teacher trainers towards the training programmes of physics teachers. In the current research, physics teacher trainers from public universities participated in the study and offered the most needed experts' opinion on improvement that should be made on methods of teaching in physics teacher education programmes. From the foregoing and by the fact that the government of Kenya subsidises the building of laboratories and the purchase of associated equipment in secondary schools, it is necessary that the ability of physics teachers to use the facilities is known. Therefore, apart from establishing the methods of teaching that physics teacher education programmes should emphasize, there was also need to establish the use of resource material by the student teachers in secondary school physics instruction in the current research.

2.5 Assessment Strategies in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

Integration of assessment into daily instruction offers students frequent opportunities to gain feedback necessary for modification of their learning and to also monitor students' progress. Continuous assessment equally provides on going opportunities for teachers to review and revise instruction, content and learning resources (Dufresne, 2004). To assess students' knowledge, skills and attitudes in physics, teachers require a variety of tools and approaches that ought to be focused on during the training of teachers (Taylor & Dana, 2003). Teachers are therefore required to ask questions, observe students engaged in a variety of learning activities in addition to examining student work in progress. It is important that teachers also guide students in peer assessment and self-assessment activities (Huaying, 2012). The information that teachers and students gain from assessment activities informs follow up actions in the classroom.

Bullock, LaBella, Clingan, Ding and Thibado (2006) have urgued that purposes, approaches and tools for assessment should demonstrate the following characteristics; should be congruent with instruction, should be continuous, be based on authentic tasks and focus on meaningful learning processes. Bullock et al. Further argued that the context of assessment should be guided by what students know, can understand and is appealing to the strengths of the students. Assessment should therefore be a collaborative process that involves students, should be multi-dimensional and uses a wide range of tools and strategies as it focuses on what students have learned and can do.

A study done to investigate aspects of assessment in teacher education and secondary school physics was conducted by Ramsey, Nemeth and Haberkorn (2013) with 1300 secondary school physics teachers from 7 Midwest states of the USA. The survey aimed at comparing the effectiveness of teaching styles and method of assessment used in high school physics classrooms. Inquiries about student preparation, pedagogy in the classrooms and effectiveness of assessment strategies as used by teachers were done. The survey data was obtained from all the participants who were also former members of the American Association of Physics. The cohort was chosen because of the high likelihood of the teachers to employ a diversity of teaching and assessment techniques as they are slightly more experienced in teaching of high school physics. Teachers gave their responses on multiple aspects of their assessment practices that enabled the researchers to uncover the most common approaches to student assessment and its purposes in the physics classroom. In the follow up interviews, questions on how the teachers used feedback from assessment to adjust elements of the course were asked. This was alongside questions on the extent of use of various categories of assessment tools that included tests, homework, project work and verbal discussions.

It was revealed that 25% of the teachers reported to have used assessment during their teaching to help students take responsibility for their own learning. Most teachers especially from the urban areas indicated that they often use the feedback from assessment to adjust their coverage of content. No teacher reported having used assessment to adjust their future instructions, and it was also realized that schools in rural and urban areas had different approaches to assessment basing on the needs of their students and the available resources. It was further established that end of topic tests, examinations and homework were the most popular techniques to assess students with percentage usage of 85.4, 68.2 and 63.2. Standard tests and project work were reported as the least techniques used with percentage usage of 33.6 and 29.0 respectively.

Assessment skills are as important component of assessment practices and without adequate assessment skills, it is unlikely that teacher assessment practices will produce desired students learning outcomes (Efendi, Rustaman & Kaniawati, 2018). And as earlier argued by Mertler and Campbell (2005), assessing students learning progress is one of the most crucial skills that new teachers need to develop if they want to make correct decisions in class. Further, the research conducted by AlKharusi (2009) on self-perceptions and skills concerning educational measurements revealed that, perceived usefulness and relevance of educational measurement is positively related to perceived skilfulness in assessment. Moreover, Schaff (2006) conducted a study in which he used descriptive survey design where

92 prospective physics teachers in Indonesia on teaching practice participated in the study. It was established that teaching experience of prospective physics teachers are limited and correlated positively with self-perceived assessment skills. It was equally revealed that assessment projects need to be integrated with students teaching and other practical experiences. As Schaff (2006) has argued, training on measurement of pre-service teacher education needs to introduce knowledge and skills within an authentic classroom context for prospective teachers to put into practice. Similar finding were also made by Alkharusi (2009) that teachers with training on educational measurement, irrespective of their teaching experience reported a higher level of perceived skilfulness in educational assessment.

The study discussed above (Ramsey et al., 2013; Schaff, 2006; Alkharusi, 2009) outlined the assessment strategies used in both physics teacher education and in secondary school physics instruction which the current study adopted in developing of the questionnaire items. Furthermore, the use of the assessment strategies by student teachers in secondary school physics instruction was also established in the current research. However, data in the studies by Ramsey et al. and Alkharusi collected data from teachers who were highly experienced in teaching secondary school physics. This may limit the findings to the experienced cadre of teachers. This created the need for a similar research to be done with pre-service physics teachers, similar to the research discussed above by Schaff in order to facilitate comparison of results, and this is what the current research sought to achieve. In addition, in the study conducted by Ramsey et al., data was collected using physics teachers' questionnaire and interviews and therefore, in order to enrich the findings, the current research incorporated views of employers of physics teachers and those of experts in physics teacher education. In the current research, data was therefore collected from physics student teachers, secondary school head teachers, heads of physics subject in secondary schools where the student teachers were on teaching practice and physics teacher trainers.

Further, existing gaps and improvements that should be made on assessment strategies used in physics teacher education programmes for acquisition of pedagogic skills were sought in the current study. Moreover, a focus was placed on the use of project work since it is key in physics assessment. As Dufresne (2004) has argued, project work develops the thinking processes, inquiry skills, and scientific attitudes of students. Similarly, the use of assessment strategies as suggested by McWilliam, Poronik, and Taylor (2008) that include: observation, interview, group assessment, students' self-assessment, student demonstrations, laboratory reports and in research reports in both physics teacher education and in secondary school physics instruction were also established in the current study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter focused on the review of literature related to physics teacher education programmes in relation to pedagogic skills needed for effective instruction and further a critique of the same. This chapter describes the methodology of how the study was conducted by discussing the research design, area of study, the target population, the sample and the sampling technique, the instruments that were used to collect data, how validity and reliability of the research instruments were determined, data collection procedures, the ethical considerations and finally the procedures of data analysis.

3.2 Research Design

The design of the study was a descriptive survey. Descriptive survey determines and reports the state of phenomena on matters such as intents, values, behaviour and characteristics possessed by individuals and groups (Kasomo, 2007). It also entails an investigation of issues as they affect an activity such as teacher education. Apuke (2017) has proposed that descriptive survey is useful when an accurate and extensive description of an educational practice is to be made and therefore, the design was considered the most appropriate method for this study. Furthermore, Krathwohl (2003) recommends the foregoing approach since it gives room for interrogation of a number of research questions thereby providing a holistic interpretation of a process. In this study, descriptive survey was used to interrogate and report on the relevance of objectives, content, methods of teaching and assessment strategies in physics teacher education programmes in relation to pedagogic skills of student teachers.

3.3 Area of Study

The research was conducted in six (6) public universities in Kenya namely, the University of Nairobi (UoN), Moi University (MU), Kenyatta University (KU), Egerton University (EU), Maseno University (MSU) and Masinde Muliro University of Science and Technology (MMUST). The UoN is located in the Central Business District (CBD) of Nairobi town, MU is located 35 km South East of Eldoret town in Uasin Gishu County, KU is located in Kiambu County and 11km from Nairobi CBD, EU is located in Nakuru County and 12km South West of Nakuru town, MSU is situated in the Northern part of Kisumu County while MMUST is located in Kakamega town. Although there are seven public universities in Kenya that were established by 2007 that are the focus of the current study, Jomo Kenyatta University of Science and Technology does not offer physics teacher education and therefore only six of the universities were selected for the study. Furthermore, the six public universities that participated in the study have been graduating over 90% of the physics teachers annually (IUCEA, 2014). These graduates have thereafter been recruited to teach in secondary schools all over the country since 2007. The six universities have collectively graduated the greatest proportion of physics teachers for secondary schools, as approximately 3000 out of the 3250 physics teachers employed in secondary schools in the 10 years that formed the basis of this study are graduates of any of the six public universities mentioned. This has been at the back drop of poor performance and low enrolment in secondary school physics that has been witnessed within the 10 years in secondary school physics as earlier discussed in the background, hence the need for research interventions.

3.4 Study Population

The study targeted physics student teachers in public universities, teacher trainers, head teachers and heads of physics subject from secondary schools where the student teachers were undertaking their teaching practice. The study population comprised 420 physics student teachers who were undertaking teaching practice in the year 2016 from 6 public universities in Kenya. Taylor and Dana (2003) have argued that students on field attachment are better placed to give an account of the training because they are able to interpret it in the context of the demands of the job environment. The influence of both the teaching experience and in-service training was controlled in this study through the selection of student teachers to participate in the study. The composition of the population of student teachers across the universities is shown in Table 3.

Table 3: Population of Physics Student Teachers

University	*N*	Percentage (%)
A	86	20.48
B	70	16.67
C	78	18.58
D	71	16.90
E	48	11.43
F	67	15.95
Total	**420**	**100.00**

The study population also included 277 head teachers and 277 heads of physics subject in secondary schools where the student teachers were undertaking their teaching practice. A population of 130 physics teacher trainers from public universities, specifically drawn from the departments of pedagogy and content also took part in the study. This enabled the researcher solicit the views of the experts needed in the current study. Sullivan (2013) has proposed that specialists in a given area should be in a position to give more specific responses that aids the researcher to uncover deeper and more specific thoughts. In this study, the physics teacher trainers were the experts in the training of teachers while the heads of physics subject in secondary schools were the immediate subject experts in the job market who collaboratively worked with the physics student teachers.

3.5 Sample Size and Sampling Techniques

Purposive sampling was used in the study where the total population of 351 physics teachers on teaching practice, 225 head teachers and 225 heads of physics subject in secondary schools where the student teachers were undertaking their teaching practice, and 108 physics teacher trainers participated in the study. As Gall and Borg (2007) have noted, purposive sampling enables the researcher to identify respondents who are rich in information and allows them to participate in the study. And in support of Gall and Borg's assertions, Ilker, Sulaiman and Rukayya (2016) have noted that purposive sampling enables the entire population that meets the criteria of specific skills set or experience desired to be included in the study. Therefore in the current study, physics student teachers were selected because of the need to check their experience in secondary school physics instruction in relation to their training at the universities. Similarly, head teachers and heads of physics subject in secondary schools where the student teachers were undertaking their teaching practice were eligible to participate in the study by virtue of having worked collaboratively with the student teachers. Moreover, physics teacher trainers specifically in the schools of Education, Sciences, computer and Human Resource and Development participated in the study because they possess an in-depth understanding of physics teacher training programmes. Each category of the sample was approximately 84% of the population while the remaining 16% were used in the pilot study. The sample frame is given in Table 4.

Table 4: Study Population and Sample Size

Category of Respondents	Study Population (*N*)	Sample Size (*n*)	Sample Size (%)
Student Teachers	420	351	83.57
Head Teachers	277	225	81.22
Heads of physics subject	277	225	81.22
Teacher Trainers	130	108	83.05

3.6 Research Instruments

The study used two data collection instruments, namely questionnaires and Document Analysis Guide (DAG). The questionnaire method was used as a primary source of gathering of the data and it enabled the researcher collect both quantitative and qualitative data on objectives, content, methods of teaching and assessment strategies in physics teacher education in relation to skills by student teachers. The survey included Questionnaire for Physics Student Teachers (QPST), Questionnaire for Secondary School Head Teachers (QSSHT), Questionnaire for Heads of Physics Subject (QHPS) and the Questionnaire for Physics Teacher Trainers (QPTT). The QPST, QSSHT and QPTT were each categorised into four parts of Tyler's (1949) model of programme evaluation that include programme objectives, content, methods of teaching and assessment (see Appendices A, B, C and D).

3.6.1 Questionnaire for Physics Student Teachers (QPST)

The QPST (see Appendix A) was used to collect data on physics teacher education programmes and on the secondary school physics instruction, the student teachers were taking part. The QPST comprised 2 sections where section 1 entailed 7 closed-ended items on background information and 1 open ended item on each of the aspects of physics teacher education programmes that include objectives, content, methods of teaching and assessment strategies. There were also open-ended questions on gaps and proposed improvements on physics teacher education programmes that allowed the student teachers to express their views freely. The second section of the QPST comprised 61 Likert scale items that were used to gather information on the relevance of objectives, content, methods of teaching and assessment strategies in physics teacher education programmes to acquisition of pedagogic skills by student teachers. The range of items was from VR – Very Relevant, R – Relevant, NS – Not Sure, I – Irrelevant to VI – Very Irrelevant.

3.6.2 Questionnaire for Secondary School Head Teachers (QSSHT)

The QSSHT (see Appendix B) collected information from heads of schools where the physics student teachers were undertaking their teaching practice and it had 3 items on the background information, 14 items on the competencies of the student teachers on a scale ranging from VG – Very Good, G – Good, A – Average, P – Poor to VP – Very Poor. And lastly, it had 1 item each on gaps the head teachers had noticed regarding secondary school physics instruction as conducted by the student teacher, and on suggestions for improvement on objectives, content, methods of teaching and assessment strategies in physics teacher education programmes to enable student teachers acquire pedagogic skills required for effective secondary school instruction.

3.6.3 Questionnaire for Heads of Physics Subject (QHPS)

The QHPS (see Appendix C) had 3 items on the background information and 41 items on the engagement of the student teachers with secondary school physics instruction. This was on a 5-point Likert scale ranging from VG – Very Good, G – Good, A – Average, P – Poor to VP – Very Poor. The QHPS also had 36 items on the frequency with which the student teachers used methods of teaching and assessment strategies in secondary school physics instruction. The frequency was equally scored on a 5-point Likert scale ranging from VF – Very Frequently, F – Frequently, NS – Not Sure, R – Rarely and VR – Very Rarely. The last part of the QHPS had a checklist on methods of teaching and assessment strategies that should be emphasised in physics teacher education programmes, and further, open ended items on gaps and suggestions for improvement on objectives, content, methods of teaching and assessment strategies in physics teacher education programmes for acquisition of pedagogic skills needed for effective secondary school physics instruction.

3.6.4 Questionnaire for Physics Teacher Trainers (QPTT)

The QPTT (see Appendix D) was categorised into 2 sections such that Section A had 3 items on background information of the respondents together with items on the relevance of objectives, methods of teaching and assessment strategies of the course(s) they teach in physics teacher education to acquisition of pedagogic skills by physics student teachers. There was also 1 item each on suggestions for improvement on the objectives, content, methods of teaching and assessment strategies in the course(s) they teach in order to make it more relevant to the acquisition of pedagogic skills required for effective secondary school physics instruction. The last part of Section A comprised 25 items on the frequency of use of methods of teaching and assessment strategies in physics teacher education programmes on a 5-point Likert scale ranging from VF – Very Frequently, F – Frequently, NS – Not Sure, R – Rarely and VR – Very Rarely. In Section B of the QPTT, respondents were asked to address items under their respective departments where 15 items on the preparedness of the physics student teachers for secondary school physics instruction were presented. Items on the relevance of objectives and content as offered by their respective departments to acquisition of pedagogic skills by the student teachers were also presented on a scale ranging from VR – Very Relevant, R – Relevant, NS – Not Sure, I – Irrelevant to VI – Very Irrelevant.

3.6.5 Document Analysis Guide (DAG)

The use of Document Analysis Guide (see Appendix E) in collecting data enabled the researcher focus on relevant literature that may shed light on the phenomenon under investigation (Creswell & Plano 2011). This instrument was preferred because it reveals the true nature of a practice in an instructional situation that includes physics teacher education and in secondary school physics instruction. O'Leary (2014) recommends the use of DAG because it is a source of unobtrusive information and it is also convenient. Moreover, Cohen and Manion (2006) urge that researchers should use DAG for purposes of methodological triangulation which is a technique that facilitates validation of data through cross-verification. The use of DAG focussed on the analysis of documents that were deemed relevant to the current study such as, the Kenya Institute of Curriculum Development (KICD) physics teaching syllabus, the Teachers' Performance Appraisal and Development (TPAD) tool, the Kenya National Examinations Council (KNEC) physics syllabus and physics teacher education programmes from public universities in Kenya. These documents gave valuable information on the extent to which the objectives, content, methods of teaching and assessment strategies in secondary school physics are catered for in physics teacher education programmes and the extent of congruence of the objectives, content, methods of teaching and assessment strategies in physics teacher education and in secondary school physics instruction. Moreover, the TPAD enabled the research consolidate the teaching standards expected of secondary school physics teachers by the employer and also, it revealed the performance gap and professional development needs of physics teachers for effective secondary school physics instruction.

3.7 Validity and Reliability of the Instruments

3.7.1 Validity

Validity is the extent to which the instruments measure what they are designed to measure (Gall & Borg, 2007). A research instrument is considered valid when its contents are relevant, appropriate and adequate such that it can yield sufficient information to answer the research questions. Frankel and Wallen (2006) have identified four types of validity namely face validity, content validity, criterion validity and construct validity. The most applicable forms of validation in the current study basing on the research design and the research instruments were face validity and content validity (Cohen & Manion, 2006). These were determined before the commencement of the actual research. Kothari (2004) have asserted that face validity of research instruments is achieved through judgement on the relevance and representation of each of the elements of the research instrument by a panel of experts. To address face validity in this study, improvement on each of the items in the data collecting instruments was done by incorporating views of my supervisors and lecturers from Maseno University (MSU), School of Education who are also experts in the area of study. By scrutinizing each item, clarity, readability and ambiguity were addressed. This ensured that each item met the intended performance. Content validity of the instruments was determined by piloting of the research instruments which formed the first phase of the study. Data collected from the pilot study was evaluated with reference to credibility, relevance and scope in answering the research questions and in addressing all the aspects of the theoretical framework that guided the study. Basing on the researcher's experience during piloting, where some respondents sought clarification on some of the items, together with experts' recommendations, adjustments were made on some of the items on the research instruments that improved the efficacy of the research instruments.

3.7.2 Reliability

Reliability is the extent to which a questionnaire, test, observation or any measurement procedure produces the same results on repeated trials (Oladimeji, 2015). The researcher established the reliability of the instruments before proceeding to collect data. The reliability of the questionnaires was established by computing a test-retest reliability coefficient. This was done after administering the instruments to the same respondents twice at an interval of two weeks (Hinton-Bayre, 2010). The respondents included 67 physics student teachers from university F (see Table 3), 38 physics heads of departments in secondary schools where the student teachers undertook their teaching practice and 22 physics teacher trainers from university F. The sample for piloting formed approximately 16% which is above the 10% minimum advanced by Krathwohl, (2003) and Thabane (2010). University F was selected for pilot study because of the need to avoid any conflict of interest that may have arisen, as Romain (2015) has argued that researchers originate from a variety of backgrounds and have different interests and inclinations. Academic and professional education affects these interests and inclination. In order to attain an objective view of the phenomena under investigation, it was deemed appropriate to use university F for the pilot study. This is in agreement with the assertions of Johnson (2016) that a researcher should demonstrate through the research processes that the findings of the study will be objective. Pearson product moment correlation (r) was used to determine the correlation coefficients where the Questionnaire for Physics Student Teachers yielded an r value of +0.74, the Questionnaire for Secondary School Head Teachers was +0.83, the Questionnaire for Heads of Physics Subject was +0.81 and Questionnaire for Physics Teacher Trainers was +0.79. This made the instruments to be judged as reliable for use as the r values for the instruments were above the recommended threshold of 0.70 (Johnson, 2016).

Reliability of the instruments was also considered with reference to the position held by Filkins and Ferrari (2004) who argue that in a descriptive study such as the current research, reliability is viewed in terms of comprehensiveness of data, as in the case of the number of items in each of the data collection instruments. They further recommend more questions on an element of study to guarantee reliable of the instrument. This informed the process of designing the questionnaire items in the current study where all areas under investigation were adequately covered by use of numerous statements on each element. The instruments were also designed such that participants responded to several categories of a given item as a way of enabling the results of the study to be reliable. And as Cohen and Manion (2006) have advised, the instruments were such that they overlap with each other somewhat, being complementary at times, and contrary at other times in order to give a richer and truer account of physics teacher education programmes and secondary school physics instruction as conducted by the student teachers.

3.8 Data Collection Procedures

Before conducting the actual study in the sampled universities and secondary schools, an approval of the research proposal by Maseno University School of Graduate Studies and the senate was sought. The proposal was then presented to the Ethics and Review Committee of Maseno University for approval. After obtaining a letter of approval from the Ethics and Review Committee (see Appendix J), the researcher further sought a research permit from the National Commission for Science, Technology and Innovation (NACOSTI). On obtaining the research permit (see Appendix K), the researcher visited each of the sampled universities and sought permission to conduct the research (see Appendix L). At the same time, a list of secondary schools where the physics student teachers were conducting their teaching practice was obtained. The region in which each of the teaching practice schools was situated was identified and all the schools were grouped as those in Western Kenya region, Nyanza region, Eastern region, Nairobi region, Rift valley region and Central Kenya region. The researcher together with five research assistants who were trained on how to administer the research instruments before the onset of the actual research were each allocated one of the regions and given a list of the secondary schools that were to be visited. Each researcher then visited the schools allocated to him/her for a meeting with the head teachers and heads of physics subject to inform them about the research, and also arranged for possible dates of collecting data. Physics student teachers were also met for introduction and booked for administration of the questionnaire within the last month of their teaching practice. This was to allow the student teachers to attain sufficient exposure to instruction in secondary school physics in order for them to check their experiences against their training at the universities. Physics teacher trainers were visited in their various universities by the researcher, briefed on the research and scheduled for the administration of the QPTT.

3.9 Ethical Considerations

Gardner (2011) has argued that researchers should operate within the ethics of respect for persons involved in the study by treating participants fairly, sensitively and with dignity. In an attempt to protect the respondents in this research, the researcher observed the ethical principles that included the need for participants to be informed about the use of data, confidentiality and the right to voluntary consent.

3.9.1 Use of Data

The researcher explained to all the participants the process in which they were to be engaged and why their participation is necessary. The researcher also explained to the participants that the information collected was to be organised in form of a thesis and disseminated in journals, conferences and pamphlets for ease of access to all the participants and stakeholders.

3.9.2 Confidentiality

To ensure confidentiality in this research, the participants were not required to write their names anywhere on the research tools and they were equally assured that the information collected was entirely meant to support the study and would not be used for any other purpose. Letters of the alphabet were used to refer to the universities because of the need for deductive disclosure of the institutions that participated in the study. Karen (2009) in support of deductive disclosure has noted that in a qualitative research, maintaining respondents' confidentiality while presenting a rich and detailed account of a process is necessary. Furthermore, Kaiser (2009) has argued that it is critically important to protect the identities of the subjects of a research to avoid disclosure risk where data from the study could be directly linked to specific persons or institutions. Further, a training program amalgamated from the physics teacher education programmes offered by public universities was used in the current research (see Appendix F) and it comprise of all the courses offered to physics student teachers during training. Further, respondents were notified that neither participants nor institutions identifications were to be used in data analysis and drawing of recommendations.

3.9.3 Informed Consent

On approval of the research proposal by the School of Graduate Studies, the University Senate, the Ethics and Review Committee of Maseno University and the National Council of Science Technology and Innovation (NACOSTI), permission to carry out the study was sought from the Vice Chancellors of the sampled universities. Permission to conduct the study in the sampled secondary schools was also sought from the head teachers, after which heads of physics subjects and physics student teachers were notified about the study. Permission to carry out the study was further sought from physics teacher trainers in the departments of pedagogy, content, human resource and computer studies in the sampled public universities before commencement of the study. Thereafter, all the participants were requested to voluntarily agree to their participation through signing of the participants' letter of consent (see Appendix I).

3.10 Data Analysis Procedures

Data collected was first examined for completeness, adequacy and credibility in responding to the items on each of the research instrument, then coded and organised for analysis using the Statistical Package for Social Sciences (SPSS) version 21. Items on the Questionnaire for Physics Student Teachers (QPST) and the Questionnaire for Physics Teacher Trainers (QPTT) on the relevance of physics teacher education programmes to acquisition of pedagogic skills by physics student teachers were scored on a scale of 5 points as follow: VR - Very Relevant = 5 points, R - Relevant = 4 points, NS - Not Sure = 3 points, I - Irrelevant = 2 points and VI - Very Irrelevant = 1 point. Rating on the items of the Questionnaire of Heads of Physics Subject (QHPS) and the Questionnaire for Secondary School Head Teachers (QSSHT) on the teaching competencies of the physics student teachers in secondary school physics instruction were also scored as: Very Good = 5 points, Good = 4 points, Not Sure = 3 points, Poor = 2 points and Very Poor = 1 point. Furthermore, items on the QHPS on the use of methods of teaching and assessment strategies in secondary school physics instruction alongside items on the frequency of use of methods of teaching and assessment strategies in physics teacher education in the QPTT were such that the scale used was Very Frequently = 5 points, Frequently = 4 points, Not Sure = 3 points, Rarely = 2 points and Very Rarely= 1 point.

Frequencies, percentages and means were computed towards interpretation of the data collected on the Likert scale. Kothari (2004) notes that in the analysis of the Likert scale data, mean scores of above 3.00 points towards the positive, mean score of 3.00 is neutral while those below 3.00 points towards the negative and therefore in the current study, means scores for the responses made on each of the items were determined by considering the mid points of the scale such that a mean score of 3.51 to 5.00 indicated relevance of the item to acquisition of pedagogic skills by physics student teachers, frequent use of the method of teaching or assessment strategy by physics teacher trainers in physics teacher education or by student teachers in secondary school physics instruction.

Mean scores of 3.51 to 5.00 also indicated that the physics student teachers were prepared on aspects of secondary school physics instruction. On items on the engagement of the student teachers with secondary school physics instruction, mean scores of 2.50 to 3.50 indicated that the student teachers were average in their engagement with regards to the item. The mean scores also indicated that the respondents were not sure of the relevance of the item to the acquisition of pedagogic skills by student teachers or that the student teachers are average on the item in secondary school physics instruction.

Similarly, a mean score of 1.00 to 2.49 indicates that the item is irrelevant in physics teacher education programmes to acquisition of pedagogic skills by student teachers. Such a mean score equally indicated that the method of teaching or the assessment strategy is rarely used by physics teacher trainers in physics teacher education or, by the student teachers in secondary school physics instruction. Since mean scores of between 2.50 and 3.50 may have different meanings such as neither agree nor disagree, undecided or no opinion (Sullivan & Anthony, 2013), reference to qualitative data was constantly made in order to give meaning of the distributions as advocated by Kulas (2008). Data was then presented in form of tables in line with recommendations by Sulivan and Anthony, and Anais Brasileiros Dermatologia (2014) that tables reveal information which could be hidden in textual form much faster.

Moreover, in current research, quantitative data was analysed using frequency counts, percentages and means as Lavrakas (2008) has indicated that frequency counts and percentages are particularly useful in expressing survey responses. Moreover, frequency counts and means quickly reveal the number of non responses, outliers and central tendencies in a given distribution. Responses to open-ended questionnaire items and data gathered through documentary analysis were arranged according to the themes and transcribed into written texts.

CHAPTER FOUR

RESULTS, ANALYSIS AND DISCUSSION

4.1 Introduction

The previous chapters of this document have outlined how the relevance of objectives content, methods of teaching and assessment strategies in physics teacher education programmes were determined in relation to pedagogic skills of student teachers. Chapter four presents the findings and discussions of the investigation that was undertaken with reference to the research questions outlined in chapter one and in perspective of Tylers' (1949) objective-centred theory on which the study was anchored.

This chapter is divided into four sections that correspond to the objectives of the study. These are to: determine the relevance of objectives of physics teacher education programmes in relation to pedagogic skills of student teachers; to determine the relevance of content in physics teacher education programmes in relation to pedagogic skills of student teachers; to establish the relevance of methods of teaching in physics teacher education programmes in relation to pedagogic skills of student teachers and to establish the relevance of assessment strategies in physics teacher education programmes in relation to pedagogic skills of Student teachers. The first part of every section in this chapter presents tabulated frequencies and means highlighting the findings on the relevance of each of the aspects of physics teacher education programmes to pedagogic skills requisite for effective secondary school physics instruction. This is followed by discussions where several remarks from student teachers, secondary school head teachers, heads of physics subjects in secondary schools, teacher trainers together with findings from documentary evidence are quoted that give meaning to the tables.

4.2 Relevance of Objectives of Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

The study sought to determine the objectives of physics teacher education programmes of public universities in relation to pedagogic skills of student teachers. Data was collected from the physics student teachers, heads of physics subject in secondary schools in which the student teachers undertook their teaching practice and also, through document analysis of the Kenya Institute of Curriculum Development physics teaching syllabus and the Kenya National Examination Council physics assessment syllabus. Further, the findings are represented in line with each of the pedagogic skills needed for effective secondary school physics instruction, and aligned to the principle of Tyler's' (1949) theory that posits what should comprise educational objectives of a training programme.

4.2.1 Relevance of Objectives of Physics Teacher Education Programmes in Relation to Subject Matter Knowledge of Student Teachers

Data from physics student teachers on the relevance of the objectives of physics teacher education programmes to acquisition of subject matter knowledge is shown in Table 5.

Table 5: Relevance of Objectives of Physics Teacher Education programmes to Acquisition of Subject Matter Knowledge (Student Teachers, n= 351)

No	Objectives of Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	To produce teachers who can effectively teach two subjects at secondary school level	312	106	18	15	0	4.47
2	To produce graduates who can participate in development of physics knowledge and processes.	171	162	3	13	2	4.39
3	To produce graduates who can contribute towards research in physics and education	128	191	16	16	0	4.23
4	To produce teachers who can effectively implement secondary school physics syllabus.	102	204	20	22	3	4.08
5	To produce teachers who can implement secondary school curriculum by organizing and executing relevant strategies and processes in curriculum implementation.	121	182	33	15	0	4.17
	Overall Mean						**4.27**

KEY:
VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant

Table 5 shows that objectives of physics teacher education programmes are relevant to acquisition of subject matter knowledge by the student teachers (*MS* = 4.27).

Data on how the student teachers engaged with the objectives of secondary school physics was also collected from the heads of physics in secondary schools where the student teachers were undertaking their teaching practice. The findings are as shown in Table 6.

Table 6: Engagement of Student Teachers with Objectives of Secondary School Physics (Heads of Physics Subject, n= 225)

No	Objectives of secondary school physics	VG *f*	Good *f*	Average *f*	Poor *f*	VP *f*	*MS*
1	An understanding of the secondary school physics objectives	46	112	53	12	2	3.83
2	Clarity in stating objectives for each lesson taught	34	101	89	1	0	3.75
3	Link between stated objectives and classroom practice	25	96	104	0	0	3.64
	Overall Mean						**3.74**

KEY:
VG Very Good, VP Very Poor MS – Mean Score (1.00 to 2.49 = Poor, 2.50 to 3.50 = Average while 3.51 to 5.00 = Good)

Table 6 illustrates that physics student teachers were good (*MS* = 3.74) with implementing objectives of secondary school physics.

In a bid to consolidate more information, data on objectives of secondary school physics was also sought for through document analysis. In this regard, the Kenya Institute of Curriculum Development (KICD) physics teaching syllabus was critically evaluated. It was revealed that the general objectives for secondary school physics curriculum that student teachers are to address include; helping the learner to discover and understand the order of the physical environment, making the learner be aware of the effects of scientific knowledge in everyday life through application to the management and conservation of the environment. From document analysis of the KICD physics teaching syllabus, it was revealed that congruency in the objectives of physics teacher education programmes and those of secondary school physics instruction existed in discovery of physics knowledge and processes and in the application of physics knowledge in the environment. Further, it was realised that little focus is placed on the subject area knowledge taught in secondary school physics in the objectives of physics teacher education programmes.

The findings of this research on the relevance of objectives of physics teacher education programmes to acquisition of subject matter knowledge of physics student teachers agree with the taxonomy of educational objectives for knowledge based level of training (Bloom, 1956). The taxonomy identifies the need for objectives to cover areas of knowledge adequately by focusing on recognition of terms, ideas, procedures and theories. Bloom also notes that objectives should cover comprehension where aspects of translation, interpretation and extrapolation are included. Objectives should further cover areas of application in which general principles and abstractions are related to specific concrete situations in the environment and society at large.

In outlining the importance of objectives of teacher education, Khan (2014) emphasised the need for teacher training to produce professional teachers who have the critical knowledge combined with practical skills, competencies and commitment required to meet the needs and expectations of stakeholders. Further, objectives of physics teacher education programmes should focus more on imparting adequate knowledge of the subject matter and enable student teachers engage more with content in secondary school physics. More importantly, Etkina (2011) has recommended that teachers should be able to balance declarative knowledge with procedural knowledge, expository teaching with inquiry based learning and balance depth of content with breadth of coverage. The objectives of physics teacher education programmes should outline how best the balancing can be achieved.

4.2.2 Relevance of Objectives of Physics Teacher Education Programmes in Relation to Assessment Skills of Student Teachers

Data on the relevance of the objectives of physics teacher education programmes to the acquisition of assessment skills was also gathered from the student teachers and findings summarised in Table 7

Table 7: Relevance of Objectives of Physics Teacher Education Programmes to Acquisition of Assessment Skills (Student Teachers, n= 351)

No	Objectives of Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	To produce teachers who can compile test items for secondary school physics students.	58	148	130	12	3	3.70
2	To produce teachers who can organize and administer test items for secondary school physics students.	106	122	75	40	8	3.79
3	To produce teachers who can construct test items for secondary school physics students.	2	48	133	152	16	2.62
	Overall Mean						**3.37**

KEY:
VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant

Table 7 indicates that objectives of physics teacher education programmes are relevant (*MS* = 3.37) to acquisition of assessment skills. However, it can be noted that the student teachers were not sure (*MS* = 2.62) of the relevance of the objective on producing teachers who can construct test items for secondary school physics instruction. This made it necessary to critically examine qualitative data on construction of assessment items in order to give meaning to the findings of Table 7. It was revealed that student teachers preferred picking test items from previous examinations to constructing the same. One of the typical responses by a student teacher on suggestions for improvements on objectives of physics teacher education programmes for acquisition of assessment skills was as follow:

> *Student Teacher 109*: *"Objectives of physics teacher education on assessment should not change as there are many past papers from which we get exams"*

The given excerpt denotes that student teachers rely on past papers to extract examinations and they are not willing to utilize a variety of approaches on developing of assessment items for their students. Also, student teachers may be experiencing difficulties in construction of assessment items and such skills should be addressed by physics teacher education programmes. While physics Heads of Subjects (HOSs) indicated the need for physics teacher education programmes to focus on objectives on formative assessment and the use of question and answer approach. One of the remarks by the HoS was as follows:

> *HoS 21*: *"Questioning techniques and ways on how to come up with a standard exam should be included in the objectives"*

The findings are in agreement with those in a research done by Vingsle (2014) that revealed that questioning is an important part of physics teachers' talk and therefore teachers should be equipped with relevant questioning techniques to enable them conduct formative assessment effectively.

The findings of the current research on the need for objectives of physics teacher education programmes to focus on the processes of formative assessment are similar to those of the Assessment Reform Group (2002) of Cambridge University School of Education. The reform group established that assessment should focus on how students learn, provide constructive guidance about how to improve and more so recognise the full range of learners' activities. The reform group concluded that principles that underpin effective assessment practices need to be included in the objectives of teacher training programmes.

Formative assessment yields information that is interpreted in relation to the progress of students towards the goals of a particular section of work. Moreover, steps that follow formative assessment depend on achievements and challenges encountered during instruction. It is therefore important that activities that comprise formative assessment are part of the objectives of physics teacher education programmes in order to guide selection of activities and strategies in physics teacher education programmes. On the other hand, assessment criteria in secondary school physics in Kenya are largely summative as common standard examinations are applied at particular levels after which secondary school students' achievement is summarised in terms of grades that have the same meaning to all (Wambugu, Changeiywo & Ndiritu, 2013). It is imperative that student teachers are equally prepared with relevant skills and knowledge that can enable them conduct meaningful summative assessment. This can be achieved when development of the objectives of physics teacher education programmes is guided by the need to focus on processes and strategies of conducting summative assessment and on development of assessment items. Findings of the current research also agree with those of a research done by Dixon and Haigh (2009) that there is high dependence on external testing in both secondary school physics and in physics teacher training programmes. There is therefore need to integrate both formative and summative assessment procedures in physics teacher education programmes to enhance the competency of physics teachers in giving valid judgement of the achievement of the learners.

4.2.3 Relevance of Objectives of Physics Teacher Education Programmes in Relation to Communication Skills of Student Teachers

Data on the relevance of objectives of physics teacher education to acquisition of communication skills was equally collected from the physics student teachers and summarised in Table 8.

Table 8: Relevance of Objectives of Physics Teacher Education programmes to Acquisition of Communication Skills (Student Teachers, n= 351)

No	Objectives of Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	To produce teachers who are professionally committed to teaching and can pursue further professional development.	226	109	0	8	8	4.53
2	To produce graduates who manage learners from varied biological, social, cultural and ecological backgrounds.	107	207	22	9	6	4.14
3	To produce teachers who can effectively execute class control and manage school set ups as social gathering.	148	185	15	3	0	4.35
	Overall Mean						**4.34**

KEY:
VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant.

Table 8 indicates that the objectives of physics teacher education programmes are relevant (*MS* = 4.34) to acquisition of communication skills. Qualitative data gathered from heads of physics subject in secondary schools where the student teachers were undertaking their teaching practice was equally analysed. It was revealed that the improvements that should be made on objectives of physics teacher education programmes should emphasis inclusion of the 21st century skills and on ethical issue and good morals. Some of the typical responses by the Heads of Physics Subjects (HoSs) were as follows:

> HoS 27: *"The current world requires physics teachers to also be creative and use their knowledge for our wellbeing and to solve immediate challenges. Objectives of training should include that"*

> HoS 296: "*Objectives of the training of physics teachers should ensure we get teachers of good character to nature our students"*

The above sentiments by physics Heads of Subjects indicate that, as much as the objectives of physics teacher education programmes are deemed relevant to acquisition of communication skills, salient areas of the programmes that should address problem solving abilities, critical thinking abilities and integrity are some of the areas that need to be entrenched in the objectives of physics teacher education programmes.

More data on objectives of secondary school physics that focus on acquisition of communication skills was equally sought through analysis of the Kenya Institute of Curriculum Development (KICD) physics teaching syllabus. It was revealed that the syllabus highlighted the need to enable the learner to acquire problem solving abilities, reason critically, cooperate in the use of physics knowledge and to prepare the learner for further education and training. Similarly, analysis of the Teachers Performance Appraisal and Development Tool (TPAD) revealed that one of the teaching standards is that physics teachers are expected to acquire and demonstrate a sense of honesty and high integrity in all aspects of the profession and life in general and also, physics teachers are required demonstrate understanding of children's rights, learner safety and protection measures and equally strong interpersonal skills are desired (see Appendix G).

In agreement with the foregoing, Brekelmans et al. (2005) have emphasised that strong written and oral skills, strong interpersonal skills that include co-teaching, team teaching, guidance and counselling, collaboration alongside problem solving skills are among the key skills that employers desire of teachers. Moreover, Higgins (2008) has urged that objectives of teacher education programmes to include aspects of global awareness such as the need to learn and work with individuals from diverse cultures, religions, ideologies and lifestyles in an environment of openness and mutual respect, as this will enable student teachers integrate more effectively in the school system.

Similar assertions are made by Trilling and Fadel (2009) and the Pacific Policy Research Centre (2010) who identifies some of the 21st century skills for teachers in the global economy as effective communication, strong ethical grounding and high productivity. They further argued that teachers need to articulate thoughts and ideas in a clearer manner, listen effectively, work effectively with diverse teams and be open minded to varying ideas and values. Good communication skills is arguably one of the work related skills that employers desire of teachers (Brekelmans et al., 2005; Wiema, 2007) and includes verbal communication, non-verbal communication, classroom organisation, classroom management and integration into the school system.

Objectives of physics teacher education programmes should also address trainees' needs with regard to understanding human psychology as revealed in this research and in developing strong interpersonal skills necessary for understanding the learning process and understanding the difficulties experienced by learners. Knowledge in human psychology makes the teacher adopt new models and methods of instruction that can facilitate attainment of set goals in consonance with the reaction of the learners (Schwartz, 2015). Earlier on, Bloom's (1950) taxonomy for setting affective goals in educational objectives advocated for appreciation of value systems and entrancing conflict resolution mechanisms in developing objectives of a teaching and learning programme. Bloom urged that, in such a case, teachers are better placed to address instructional demands more effectively. Similar sentiments were made by Etkina (2011) that objectives of physics teacher education programmes should include the 21st century knowledge and skills, and focus on development of long-term value system that is pervasive, consistent and predictable.

4.2.4 Relevance of Objectives of Physics Teacher Education Programmes in Relation to Skills in use of Resource Materials by Student Teachers

Student teachers were also asked to note the relevance of the objectives of physics teacher education to acquisition of skills in use of resource materials. Findings are shown in Table 9.

Table 9: Relevance of Objectives of Physics Teacher Education Programmes to Acquisition of Skills in use of Resource Material (Student Teachers, n= 351)

No	Objectives of Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	To produce graduates who can select, design and use educational media resources effectively.	161	148	27	12	3	4.29
2	To produce teachers who can effectively manage physics laboratory equipment	168	138	20	15	10	4.25
3	To produce teachers who can effectively manage resources in teaching of physics	103	169	37	23	19	3.89
	Overall Mean						**4.14**

KEY:
VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant

Table 9 indicates that objectives of physics teacher education are relevant (*MS* = 4.14) to acquisition of skills in use of resource materials by the student teachers. More information on the extent to which student teachers engaged with objectives of secondary school physics on the use of resource materials in secondary school physics instruction was gathered from the heads of physics subject in secondary schools where the student teachers were undertaking their teaching practice. Findings are shown in Table 10.

Table 10: Engagement of Student Teachers with Objectives on Use of Resource Materials (Heads of Physics Subject, n= 225)

No	Item	VG *f*	Good *f*	Average *f*	Poor *f*	VP *f*	*MS*
1	Extent of stating objectives for laboratory work	18	35	101	55	16	2.92
2	Clarity of stating objectives on the Use of instructional resources	12	52	103	49	9	3.04
3	Link between stated objections and selection of resource material	28	56	122	19	0	3.41
4	Use of resources to attain the stated objectives	26	82	95	22	0	3.49
	Overall Mean						**3.22**

KEY:
VG Very Good VP Very Poor MS – Mean Score (1.00 to 2.49 = Poor, 2.50 to 3.50 = Average while 3.51 to 5.00 = Good)

Table 10 demonstrates that student teachers were average (*MS* = 3.22) in engaging with the objectives of secondary school physics on use of resource materials. An explanation to this was sought in the qualitative data gathered from the heads of physics subject (HoS). The following responses regarding suggestions for improvement of the objectives of physics teacher education programmes made by one of the physics Heads of Subjects was as follow:

> *HoS 126: "Physics is a practical subject but it is rare to see teaching practice teachers conduct hands on activities with the students so objectives of physics teacher education should look into that."*

From the remarks made by HoS 126, student teachers are apparently not engaged with the practical and psychomotor aspects of the subject hence the need for physics teacher education programmes to enhance student teachers' skills in use of resources. The findings are supported by the checklist for quality benchmarks of instructional materials that clearly articulated learning goals and objectives on use of resources that are engaging and relevant should be considered for any meaningful instruction in secondary school physics (Association of American Publishers, 2016).

More data on objectives of secondary school physics was further consolidated from documentary evidence where the Kenya Institute of Curriculum Development (KICD) physics teaching syllabus was scrutinized. It emerged that the objectives on use of resource material are centred around applying the principles of physics in construction of appropriate scientific devices using available resources and on acquisition of skills required to use the resource materials. Similarly, little was mentioned on construction of scientific devices in the objectives of physics teacher education programmes as offered by public universities, on improvisation and on the use of project work in teaching of physics, yet, these are some of the key areas where resource materials are largely utilised in light of the KICD secondary school physics teaching syllabus.

Further, as the Association of American Publishers (2016) have noted, resources used in the teaching and learning process should give opportunities for differentiated learning and be adoptable for individual learning styles and needs. These sentiments are shared by Jarosievitz (2017)) that the current reform effort in science education requires substantive change in how science is taught. Jarosievitz further laments that undergraduate science courses typically communicate science as a body of facts and rules to be memorised rather than a way of knowing about the natural world. This is evident when science laboratories in colleges fail to teach science as inquiry. He recommends that, if reform is to be accomplished, training of science teachers must include experiences that engage prospective teachers in active learning that builds their knowledge, understanding and ability in effective instruction by modelling good teaching of science and effective use of resources

Similarly, in identifying the 21st century skills required of physics teachers, Caruso and Kvarik (2005) emphasise the need for teachers to be acquainted with knowledge in the use of resource materials. This enables the teachers to select teaching aids and models appropriately, use them effectively and improve on the existing teaching aids where necessary. Apparently, effective use of resource materials in secondary school physics instruction depends on the training that teachers undertake, more so, the call for objectives of physics teacher education programmes to focus on selection and use of resource materials in inquiry-based physics instruction.

4.2.5 Relevance of Objectives of Physics Teacher Education Programmes in Relation to Skills in use of Information Technology by Student Teachers

Student teachers further noted the relevance of objectives of physics teacher education programmes to acquisition of skills in use of information technology. The findings are shown in Table 11.

Table 11: Relevance of Objectives of Physics Teacher Education Programmes to acquisition of Skills in use of Information Technology (Student Teachers, n= 351)

No	Objectives of Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	To produce teachers who can effectively utilize information technology in teaching of physics	101	125	97	25	3	3.84
2	To produce teachers who can effectively utilize information technology in assessment of physics	78	88	125	52	8	3.65
3	To produce teachers who can effectively utilize information technology in keeping records in Physics	93	116	117	24	1	3.85
	Overall Mean						**3.78**

KEY:
VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant

Table 11 indicates that objectives of physics teacher education programmes are relevant (*MS* = 3.78) to acquisition of skills in use of information technology by the student teachers. Moreover, information on the engagement of physics student teachers with the objectives of secondary school physics on use of information technology is shown in Table 12

Table 12: Engagement of Student Teachers with Objectives on Use of Information Technology (Heads of Physics Subject, n= 225)

No	Item	VG *f*	Good *f*	Average *f*	Poor *f*	VP *f*	*MS*
1	Stating objectives on use of information technology in teaching physics	13	28	34	82	68	2.27
2	Stating objectives on use of information technology in assessment of physics	8	21	55	91	50	2.32
3	Stating objectives on use of information technology in keeping records in physics	0	7	79	98	41	2.23
	Overall Mean						**2.27**

KEY:

VG   Very Good   VP Very Poor MS – Mean Score (1.00 to 2.49 = Poor, 2.50 to 3.50 = Average while 3.51 to 5.00 = Good)

From Table 12, it is evident that student teachers were poor (*MS* = 2.27) in use of information technology in secondary school physics instruction. A scrutiny of the Kenya Institute of Curriculum Development (KICD) physics teaching syllabus also revealed that little was mentioned on use of information technology in physics instruction. Further, one of the performance gaps identified in the Teacher Performance Appraisal and Development Tool (TPAD) is ICT integration in learning. This made it necessary to critically look at TPAD forms completed by physics teachers from which it was revealed that the teachers were in need of training in ICT (see Appendix H)

The findings of this research are similar to those of a study done by Montebon (2015) that aimed to develop objectives for a contextualised student teacher enhancement programme in the Philippine's Normal University. Findings of the research done by Montebon indicated that one of the areas in which pre - service teacher required enhancement was in the use of information technology in teaching and evaluation. The study further revealed that the integration of computer assisted instruction in physics classrooms by the student teachers from the Normal University was poor (*MS* = 2.83). It was therefore recommended that the objectives of physics teacher education programmes should seek to enhance acquisition of skills in use of information technology. Hitherto, according to Zahra and Ali (2014), information technology is used to enhance learning and it is important that teachers be comfortable using it to ensure that students get its full advantage. It is important that physics teachers are trained on how to plan, create and deliver instruction within a technological setting. Further, Zahra and Ali argued that, as much as training in technology more often appears to focus on technological knowledge and skills, it leaves teachers with difficulty in applying it in their students' learning. It is therefore necessary that the interaction between technology, pedagogy and content is outlined in the objectives of physics teacher education programmes as means of effective use of information technology in secondary school physics instructions.

Similar sentiments were made by Westera (2015) that in most cases, information technology in teacher education is used as a source of information rather than a process-based means for knowledge construction. Westera equally noted that it makes a difference when technology is used as a pedagogical tool of teaching and learning of physics. This is more practical by means of carefully structured activities designed for effective acquisition of subject matter knowledge (Anwaruddin, 2015). Standards have further been proposed by leading science education organisations for the need to integrate information technology in physics classrooms both in the training of teachers and in secondary school (Flick & Bell, 2000). At both levels, it is suggested that objectives of physics teacher education programmes should guide the introduction of technology in the context of physics content and should purpose to make scientific views more accessible. Earlier, Shelly, Gunter and Gunter (2012) argued that information technology can provide the appropriate medium for teachers to nurture high level thinking in students.

In support of the suggestions made by of Flick and Bell (2000), Brekke and Hogstad, (2010) have argued that objectives of physics teacher education programmes should be able to give guidance on use of resource material in physics instruction. This is because effective teaching has gone beyond the use of traditional approaches to integration of information technology in the physics classroom. Williams and Nguyen (2012) and Aina (2012) have further summarized the following as areas in which information technology can be used in the physics classroom as learning resources; educational software, video resources and internet services. Aina (2012) equally asserted that computers can be put to different use in teaching physics. These may vary from simulations, computer data acquisitions to animations. There are also computer assisted instruction tools like spread sheets and word processors that can be used to collect and analyse data especially for representing information in various ways such as text picture, tables and graphs. While Besty (2012) has indicated that computer software can be used to teach abstract concepts or observe abstract skills in physics whose mechanisms teachers cannot explain clearly because of the complexity of the concepts. Moreover, experiments that are very difficult to carry out in the laboratories could be simulated.

From the foregoing, technology is called upon for instructional organization of learning, to support face-to-face lectures, for course management system and for computer based instruction. Also information technology can be used in physics instruction for communication as it offers communication options in the use of E-mail system, websites and software system for text- based chats. Sentiments supported by Nguyen, Williams and Nguyen (2012) that learning activities could be communicated through e-mail system, teachers can send assignments and activities through e-mail, and can supervise students' projects by e-mail. Therefore, use of information technology and associated computer technology should be anchored on the objectives of physics teacher education programmes more so, there is urgent need for integration of information technology and pedagogy to enhance the delivery of physics content.

4.3 Relevance of Content in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

Tyler's (1949) theory on which the current study was anchored posits that what learning experiences should be developed to enable students achieve the objectives of a programme? This guided the determination of the relevance of content in physics teacher education programmes, where data was collected from physics student teachers, heads of physics subjects in secondary schools in which the student teachers were conducting their teaching practice, physics teacher trainers and also through document analysis of the physics teacher education programmes of public universities, Kenya Institute of Curriculum Development (KICD) physics teaching syllabus, KNEC physics syllabus and the Teachers Performance Appraisal and Development (TPAD) tool. Findings are represented in line with the pedagogic skills needed for effective secondary school physics instruction.

4.3.1 Relevance of Content in Physics Teacher Education Programmes in Relation to Subject Matter Knowledge of Student Teachers

Data collected from the student teachers on the relevance of content in physics teacher education programmes to acquisition of subject matter knowledge is summarised in Table 13.

Table 13: Relevance of Content in Physics Teacher Education Programmes to Acquisition Subject Matter Knowledge (Student Teachers, n= 351)

No	Content in Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Mechanics	125	199	12	15	0	4.24
2	Electricity and Magnetism I	130	200	9	12	0	4.28
3	Optics	115	135	38	32	31	3.88
4	Thermal Physics	82	116	100	23	30	3.56
5	Dynamics	59	98	102	64	28	3.27
6	Electricity and Magnetism II	91	182	54	22	2	3.96
7	Oscillations and Waves	93	169	62	15	12	3.90
8	Empirical Ideas of Quantum Physics and Relativity	9	21	16	148	157	1.79
9	Introduction to Solid State Physics	18	85	90	146	12	2.86
10	Quantum Mechanics I	29	78	139	103	3	3.09
11	Classical Mechanics	64	97	127	52	11	3.71
12	Solid State Physics	53	55	120	116	7	3.08
13	Statistical Mechanics	44	77	114	113	3	3.13
14	Quantum Mechanics II	1	16	107	171	56	2.25
15	Electrodynamics	10	62	142	111	26	2.77
	Overall Mean						**3.32**

KEY:

VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

Data represented in Table 13 indicates that student teachers were not sure (*MS* = 3.32) of the relevance of content in physics teacher education programmes to acquisition of subject matter knowledge. It is further noted that content in Electricity and Magnetism I (*MS* = 4.28), Mechanics (*MS* = 4.24), Electricity and Magnetism II (*MS* = 3.96), Oscillation and Waves (*MS* = 3.90), Optics (*MS* = 3.88), Classical Mechanics (*MS* = 3.71) and Thermal Physics (*MS* = 3.56) were relevant to acquisition of subject matter knowledge. However, content in Empirical Ideas of Quantum Physics and Relativity (*MS* =1.79) and Quantum Mechanics II (*MS* = 2.25) was found to be irrelevant to acquisition of subject matter knowledge by the student teachers. This implies that content in physics teacher education programmes should focus more on physics content that is deemed relevant for acquisition of pedagogic skills by student teachers such as mechanics, electricity and magnetism, oscillation and waves and also on thermal physics. Data on engagement of the student teachers with physics content in secondary school instruction was also collected from the heads of physics subject in secondary schools where the student teachers were undertaking their teaching practice. The data is summarised in Table 14.

Table 14: Engagement of Student Teachers with Content in Secondary School Physics Instruction (Heads of Physics Subject, n = 225)

No	Item	VG *f*	Good *f*	Average *f*	Poor *f*	VP *f*	*MS*
1	Physics content knowledge	32	24	128	34	7	3.17
2	Ability to make inference to physics content knowledge	12	17	116	75	9	2.82
3	Level of engagement with physics content knowledge during instruction	44	86	77	17	1	3.69
4	Level of understanding of emerging issues in physics	11	46	134	29	5	3.13
5	Relating of physics content to real life situations	17	48	61	53	46	2.50
6	Ability to discuss ideas involving physics content	10	52	78	73	12	2.88
	Overall Mean						**3.03**

KEY:
MS – Mean Score (1.00 to 2.49 = Poor, 2.50 to 3.50 = Average while 3.51 to 5.00 = Good)

Table 14 shows that student teachers were average (*MS* = 3.03) in their engagement with physics content in secondary school instruction. Analysis of qualitative data from questionnaire of heads of physics subjects revealed that one of the gaps evident in teaching of secondary school physics by the student teachers was the inability to link content to real life situations. One of the outstanding remarks noted from one of the physics Heads of Subject was as follows:

> *HoS 14 "The TP teacher has difficulty in delivery of content in some topics like magnetic effect of an electric current. The way he handles content in form 2 physics is unsatisfactory as he has difficulties with applications"*

The statement by HoS 14 indicates that engagement of the student teacher with content in secondary school physics was unsatisfactory hence the need for physics teacher education programmes to address such concerns. Conant (1963), Niess (2005) and Okwelle (2014) have equally raised similar concerns that physics teachers' conception of subject matter knowledge shapes classroom practice and affects their students' understanding. However, several authors have pointed out to the problematic nature of pre-service teachers' content knowledge (Shulman, 1986; Halim & Meerah, 2002; Driel & Berry, 2010). The authors have argued that many pre-service teachers were found to have limited subject matter knowledge with several misconceptions that made it difficult for the teachers to develop the required pedagogical knowledge. This interfered with student teachers' preparation for the lessons and therefore, teacher education programmes should equip student teachers with adequate and relevant subject matter knowledge in order for the teacher to improve on classroom delivery.

Findings of the current research that student teachers were average in their engagement with content in secondary school physics departs from that of Appleton (2003) who established that beginning physics teachers have limited content knowledge. This could have been as a result of all the physics content in secondary school physics having been addressed in the content in physics teacher education programmes as revealed from documentary evidence. This indicates that there is room to achieve an improved understanding of physics content by the student teachers in Kenya especially is reviews on content in teacher education are such that more emphasis is place areas covered in secondary school physics such as electricity and magnetism, mechanics, waves and thermal physics, while little emphasis is placed on empirical ideas of quantum physics and relativity and on quantum mechanics.

Of equal importance is that Peters (1977), Van Driel and Berry (2012) have reported that subject content is an essential component of teacher education and therefore the engagement of student teachers with content in secondary school physics instruction should be good for effective secondary school physics instruction. Moreover, Berry notes that, if anything is to be regarded as specific preparation for teaching, then priority must be given to a thorough grounding on what is to be taught. Niess (2005) has equally argued that the role of content knowledge in teaching is to help students learn not only the major domain of the subject, but also enable students to participate in human thought and inquiry. The findings of the current research therefore point towards the need for content in physics teacher education programmes to focus on critical areas that are key to effective instruction in secondary school physics that includes mechanics, thermal physics, electricity and magnetism and waves.

Subject matter knowledge involves the understanding of the depth and organisation of knowledge in a specific field. This influences how teachers structure and teach lessons (Wilson & Wineburg, 1988; Silver, 2017). Harrison and Jones (2017) have established that teaching entails helping others to learn and therefore, an understanding of the subject matter knowledge is a central requirement of teaching. Sufficient and relevant subject matter knowledge enables student teachers to engage with intellectual ideas constructively. This makes teachers gain control over their students' reasoning in secondary school physics. When content knowledge of physics teachers is limited, it interferes with the processes of teaching that includes selection of learning activities, giving helpful explanations and evaluation of students learning. Jing-Jing (2014) and Pinamang (2017) have contributed to this debate by noting that relevant content knowledge enables the teacher to extend beyond the specific topics of the curriculum. Teachers become more capable of defining for students the accepted truths in a domain. They also explain why a particular proposition is warranted and worth knowing. Similar sentiments were shared by Wiema (2007) who notes that emphasis should be placed on the acquisition of subject matter knowledge for effective instruction in secondary school physics.

From the foregoing, subject matter knowledge is acknowledged as a central component of what teachers need to know (Ball & McDiarmid, 2017). Moreover, helping students to learn the subject matter involves more than the delivery of facts and information since the goal of education is to assist students develop intellectual abilities to enable them participate in the major domain of human thought and inquiry and further use intellectual ideas and skills as tools for gaining control over every day real world problems. Ball and McDiarmid have further noted that the teachers' own subject matter knowledge influences their efforts to help students learn content knowledge and when teachers possess inaccurate information or have got a narrow conception of content, they may pass on these ideas to their students (Conant, 1963; Van Driel & Berry, 2010).

Boyo (2010) has equally argued that an understanding of subject matter knowledge by student teachers is a necessity as it determines the extent to which the student teachers develop lessons with reference and inference to emerging issues, relating physics to real life and on the management of the laboratory processes. In light of the findings of this research alongside assertions by Van Driel & Berry (2010); Deborah & Williamson (2014); Couso (2009) and Boyo (2010), it is necessary that emphasis in content in physics teacher education programmes in public universities is placed on a wide range of the domain of knowledge necessary for holistic preparation of physics student teachers.

4.3.2 Relevance of Content in Physics Teacher Education Programmes in Relation to Assessment Skills of Student Teachers

Information regarding the relevance of physics teacher education programmes in relation to acquisition of assessment skills was also gathered from the physics student teachers and represented in Table 15.

Table 15: Relevance of Content in Physics Teacher Education Programmes to Acquisition of Assessment Skills (Student Teachers, n= 351)

No	**Content in Physics Teacher Education**	**VR** *f*	**R** *f*	**NS** *f*	**I** *f*	**VI** *f*	***MS***
1	General Methods of Teaching	197	138	13	3	0	4.51
2	Tests and Measurements	207	64	71	9	0	4.34
3	Special Methods of Teaching Physics	105	122	78	37	9	3.79
4	Teaching Practice	134	152	48	14	3	4.14
5	Project Work on Teaching Practice	142	108	93	8	0	4.09
	Overall Mean						**4.17**

KEY:
VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

Table 15 shows that content in physics teacher education programmes is relevant (*MS* = 4.17) to acquisition of assessment skills by the physics student teachers and therefore it should be upheld in the training programmes. Moreover, more data was gathered from the heads of physics subject in secondary schools where the student teachers were undertaking their teaching practice. The findings are represented in Table 16.

Table 16: Engagement of Student Teachers with Assessment in Secondary School Physics (Heads of Physics Subject, n = 225)

No	Item	VG *f*	Good *f*	Average *f*	Poor *f*	VP *f*	*MS*
1	Use of end of topic tests	43	73	89	19	1	3.61
2	Use of standard tests	56	70	87	12	0	3.76
3	Use of a variety of assessment strategies in physics instruction	8	13	134	49	21	2.64
4	Use of feedback from assessment to adjust instruction	2	6	59	143	15	2.27
5	Assessment of laboratory work	0	8	32	111	74	1.89
5	Construction of assessment items for students	1	11	66	102	45	2.20
6	Use of project work as an assessment strategy	0	7	27	101	90	1.78
7	Assessment of students with learning disabilities	1	3	6	121	94	1.65
8	Performance of learners in physics examinations	26	33	73	77	16	2.89
	Overall Mean						**2.86**

KEY:
MS – Mean Score (1.00 to 2.49 Poor, 2.50 to 3.50 Average, while 3.51 to 5.00 Good)

Table 18 shows that student teachers were average (*MS* = 2.86) in their engagement with assessment in secondary school physics instruction. It also demonstrates that student teachers were good in the use of standard tests (*MS* = 3.76) and end of topic tests (*MS* = 3.61), while they were poor at use of feedback from assessment to adjust instruction (*MS* = 2.27), assessment of laboratory work (*MS* = 1.89), construction of assessment items (*MS* = 2.20), use of project work as an assessment strategy (*MS* = 1.78) and in assessment of students with learning disabilities (*MS* = 1.65). These findings imply that as much as content in physics teacher education programmes is relevant to acquisition of assessment skills by student teachers, there is need to enhance the role of laboratory reports and project work as an assessment strategy in secondary school physics instruction. Also, student teacher should be further guided on the use of assessment results in planning of subsequent engagements in physics instruction.

Further, the Teacher Trainers (TT) responses on the open- ended questions regarding improvements that should be made on the content of the courses that they teach for acquisition of assessment skills by the student teachers were as follows:

> *TT 42 on Tests and Measurement: "There is need to incorporate modalities of assessment in secondary schools in what we teach at university"*

> *TT 101 on Special methods of teaching physics: "several assessment methods should be used and perhaps tailored to content in secondary school syllabus"*

The above suggestions by the physics teacher trainers imply that tests and measurement course as offered by the universities is yet to entrench all the aspects of secondary school physics. And from the remarks made by Teacher Trainer 101, the aspects of assessment that should be enhanced in the content of physics teacher education programmes are largely on use of a variety of assessment strategies for effective secondary school instruction. Further, findings of this study at large are in agreement with those in a study conducted by Neff and Nebel (2004) in Coconino County in Arizona. In the study by Neff and Nebel, participants were largely government employed teachers with several years of experience in teaching physics. It was established that the participants requested for professional development in the area of assessment of academic standards of their learners. Similar findings have been made in the current research where there is need to improve on assessment techniques taught and used in physics teacher education programmes. There is therefore need for content in physics teacher education programmes to cover assessment techniques and strategies that are necessary for student teachers to conduct meaningful assessment in secondary school physics instruction.

Assessment can either be formative or summative in that, summative assessment is used to summarise what students know and can do at certain times for the need of reporting achievements and progress (Assessment Reform Group, 2004). On the other hand, formative assessment informs stakeholders on the extent of attainment of the learning objectives. From the findings of the current study, it is evident that physics student teachers were good at items on summative assessment while poor at aspects of formative assessment. The revelation on good implementation of strategies of summative assessment by the student teachers partially agrees with assertions made by Jones and Alcock (2014) that the focus on what students have learnt is one of the effective approaches to assessment hence the call for use of end of topic testing and standard testing. Marsh (2007) has also observed that assessment entails moment to moment observation of students' actions and to assess students' knowledge, skills and attitudes, teachers require a variety of tools and approaches such as questions, observe students engaged in a variety of learning activities and examine students work in groups. Similarly, Marcelo and Marina (2014) have argued that teachers need to engage students in peer assessment and self-assessment activities and therefore it is necessary that content in physics teacher education programmes embeds both summative and formative assessment techniques in the content of physics teacher education programmes.

In contributing towards the debate on assessment in learning, Marcelo and Marina (2014) have asserted that formative assessment is a systematic process of gathering information about what a student knows, is able to do and is learning to do, and is therefore meant to inform teaching and at the same time seeks to improve the learning process. Several studies have demonstrated that substantial learning gains are possible when teachers use formative assessment in their classroom practice (William, 2006; Vingsle, 2014). Similarly, Charlotta (2014) has observed that sufficient knowledge about how to help in-service teachers and pre-service teachers develop their formative classroom practices is lacking. It is therefore necessary to integrate assessment in the content of physics teacher education programmes.

Furthermore, in a research conducted by Heritage (2007) that sought to establish the ability of teachers to interpret the answers of students on how to respond and plan the next step of instruction, it was revealed that the ability of teachers to use assessment information to plan the next step of instruction was the most difficult step. Similarly, Schneider and Gowan (2013) found that providing students with targeted feedback was the most difficult task for teachers. Physics teachers therefore need to be assisted in management of the interpretation and judgement phases of formative assessment probably through enriching the content in physics teacher education programmes so that trainees can be acquainted with knowledge and skills on eliciting information, passing judgement basing of the information collected, make appropriate adjustments and being able to follow procedures that assure credibility and minimise bias in assessment.

The findings of this study also indicate the need for content in physics teacher education programmes to address the effective use of teaching and associated assessment models in secondary school physics that include use of project work as an assessment strategy, contruction of assessment items and assessment of students with learning abilities. These findings conform to sentiments that were earlier made by Stiggins (1992) that teachers should be aware of the strengths and weakness of various teaching and assessment methods and that teacher education should enable them choose appropriate approaches in order to attain given achievement targets. Revelation by the current study that student teachers were poor in assessment of laboratory work, the use of project work as an assessment strategy and in use of a variety of assessment strategies which are linked to experimentation and inquiry-based learning at large calls for a re-look at the content of physics teacher education programmes.

Experimentation and inquiry-based learning is pivotal in physics because it engages students with experiences in designing investigation, developing collaborative learning skills and in learning skills that are vital to success in lifelong endeavours. Sokolowska and Michelini (2018) have argued that excellent laboratory programmes do not happen by chance but require thought and planning, and their broad implication require the best efforts of the physics community. This can probably start with redefining content in physics teacher education programmes by placing emphasis on acquisition of the required experimental techniques and subsequent assessment of laboratory processes. Content in physics teacher education programmes should further incorporate several inquiry-based learning techniques and associated assessment models.

4.3.3 Relevance of Content in Physics Teacher Education Programmes in Relation to Communication Skills of Student Teachers

The relevance of content in physics teacher education to acquisition of communication skills was also determined in the current study from the student teachers and findings are summarised in Table 17.

Table 17: Relevance of Content in Physics Teacher Education Programmes to Acquisition of Communication Skills (Student Teachers, n= 351)

No	Content in Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Communication Skills I	201	107	41	2	0	4.44
2	Communication Skills II	222	82	40	7	0	4.48
3	Quantitative Skills	110	101	86	44	10	3.73
4	State, Society and Development	92	137	88	27	7	3.79
5	Entrepreneurship	98	107	97	34	15	3.68
6	HIV and AIDS Instruction	212	107	15	7	10	4.44
7	Research Methodology	88	121	103	28	11	3.70
8	General Methods of Teaching	102	116	121	9	3	3.89
9	Introduction to Psychology	238	93	18	2	0	4.62
10	Human Growth and Development	204	39	98	10	0	4.25
11	Human Behaviour, Guidance & Counselling	244	106	1	0	0	4.69
12	Philosophy of Education	102	128	105	16	0	3.90
13	History of Education	98	189	58	6	0	4.25
14	Sociology & Comparative Education	102	176	61	5	7	4.03
15	Introduction to Logic and Critical Thinking	122	147	79	2	1	4.10
16	Environmental Education	201	105	34	2	9	4.39
17	Educational Administration Theories and Institutional Operations	198	111	39	3	0	4.44
18	Planning and Economics of Education	172	132	26	21	0	4.30
19	Introduction to Special Needs Education	100	179	51	17	4	4.01
20	Teaching Practice	304	32	14	1	0	4.82
	Overall Mean						**4.20**

KEY:

VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

Table 17 indicates that content in physics teacher education programmes is relevant (*MS* = 4.20) to acquisition of communication skills. Moreover, data on communication skills of physics student teachers in secondary school physics instruction was established. The findings are indicated in Table 18.

Table 18: Communication Skills of Student Teachers in Secondary School Physics Instruction (Heads of Physics Subject, n = 225)

No	Item	VG *f*	Good *f*	Average *f*	Poor *f*	VP *f*	*MS*
1	Verbal communication	14	61	90	57	3	3.12
2	Non-verbal communication	12	66	57	81	9	2.96
3	Classroom organisation	34	107	58	23	3	3.65
4	Classroom management	44	83	86	12	0	3.71
5	Management of students with learning disabilities	2	6	49	104	64	2.01
6	Management of students with problems of health	4	8	43	127	43	2.12
7	Management of students with problems of drug abuse	0	4	12	139	70	1.78
8	Management of students with problems of discipline	3	6	18	133	65	2.17
9	Critical thinking skills	4	3	57	99	62	2.06
10	Problem solving skills	1	2	81	73	68	2.09
	Overall Mean						**2.56**

KEY:
MS – Mean Score (1.00 to 2.49 = Poor, 2.50 to 3.50 = Average while 3.51 to 5.00 = Good)

Table 18 indicates that communication skills of student teachers in secondary school physics instruction was average (*MS* = 2.56). Table 18 also shows that student teachers were good at classroom management (*MS* = 3.71) and in classroom organisation (*MS* = 3.65) but poor in the following areas; management of students with problems of drug abuse (*MS* = 1.78), management of students with learning disabilities (*MS* = 2.01), critical thinking skills (*MS* = 2.06), problem solving skills (*MS* = 2.09), management of students with health problem (*MS* = 2.12) and in management of students with problems of discipline (*MS* = 2.17). When the physics teacher education programmes were critically looked at in relation to the KICD physics teaching Syllabus and the TPAD tools, it was clear that little is captured on management of students with learning disabilities, management of students with problems of health, drug abuse and discipline. This implies that there is need for content in physics teacher education programs to be revamped in order to address the emerging trends in secondary school physics in order to enable student teachers communicate effectively during instruction.

To give meaning to these findings, qualitative data from heads of physics subject was scrutinized and the following remarks on existing gaps in physics teacher education programmes in relation to acquisition of pedagogic skills by student teachers were noted:

> *HoS 54*: *"The teacher has not established a good relationship with the class."*

> *HoS 213: It is important that teachers on teaching practice be taught on how to use appropriate language in and out of class"*

From the above statements, it is clear that communication skills exhibited by the student teacher were inadequate in line with the demands in physics classrooms. it is necessary that content in physics teacher education programmes be tailored to improving communication skills needed in secondary school instruction, in which learners are drawn from diverse culture and at times, with varied psychological, social, economic or physical needs.

Information emerging in this study that student teachers were average in their communication abilities differs from findings by Bee (2012) in a study conducted to examine the pre-service teachers' perception of their communicative strengths and weaknesses in a multilingual and multicultural society in Singapore. Findings from the study done by Bee indicated that Singaporean teachers face tensions with communication and had weaknesses with pronunciation, vocabulary and were poor listeners. A different scenario probably exists in Kenya because the physics student teachers were noted to be average in classroom communication, classroom organisation and classroom management.

More data on communication skills of the physics student teachers was collected from head teachers in secondary schools where the student teachers undertook teaching practice and findings are shown in Table 19.

Table 19: Communication Skills of Student Teachers in Secondary Schools (Secondary School Head Teachers, n = 225)

No	Item	VG *f*	Good *f*	NS *f*	Poor *f*	VP *f*	*MS*
1	Communication in the classroom	18	74	46	86	1	2.65
2	General management skills	52	63	61	38	11	3.48
3	Management of behaviour in the classroom	14	59	57	81	14	2.90
4	Integration in the school system	33	96	52	37	7	3.49
5	Collaboration with other teachers	16	108	42	54	5	3.34
6	Contribution towards the attainment of school values	18	87	114	5	1	3.51
	Overall Mean						**3.23**

KEY:
VG Very Good NS Not Sure VP Very Poor MS – Mean Score (1.00 to 2.49 = Poor, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Good)

From Table 19, secondary school head teachers indicated that they were not sure (*MS* = 3.23) of the communication skills of student teachers. Table 19 also indicates that secondary school head teachers were not sure of the communication skills of the student teachers in the classroom (*MS* = 2.65) and on management of behaviour in classrooms (*MS* = 2.90). Because of the need to for student teachers to communicate effectively in physics instruction, it is necessary that content in physics teacher education programmes focus on equipping the student teachers with skill necessary to manage varied behaviour patterns for effective instruction.

Furthermore, document analysis of the Teachers Performance Appraisal and Development (TPAD) tool was found to emphasise the need for teachers to utilize strategies for managing students with a wide range of needs as one of the key performance competency areas for teachers. The other areas highlighted by the TPAD include professional knowledge and application with a focus on the subject content, availability and use of professional records and time management by the teacher. In addition, the TPAD requires the determination of the teachers' level of innovation, creativity, collaboration, team work and level of protection of the learners. It was evident that the TPAD highlights the need for physics teachers to exhibit solid communication skills for effective instruction in secondary schools (see Appendix G). Further scrutiny of completed TPAD forms revealed that some of the performance gaps to be addressed in teacher support programs and teacher development training include; inadequate knowledge of legal and professional documents governing education, poor interpersonal skills and inadequate skills in innovation and creativity.

Teacher quality has been consistently identified as the most important factor in students' achievement and that a quality teacher should have a combination of mastery of subject matter, command a broad set of pedagogical skills and has excellent communication skills (McCaffrey, Lackwood, Koretz and Hamilton, (2003). Rice (2003) and Goe (2007) have established that course work during pre-service teacher preparation contributes to the teacher quality and quality teachers are committed and reflect upon their teaching practices.

Of equal importance is that content in physics teacher education should enable student teachers acquire the knowledge and skills that are desired by the employer and other stakeholders in education. Employers desire that teachers have strong written and oral communication skills and strong interpersonal skills that include collaboration, team work, and guidance and counselling skills (Brekelmans *et al*, 2005; Mash, 2007). Similarly, Silver (2017) has argued that communication skills are both receptive and expressive and teachers must be skilled at listening to their students as well as being able to give clear explanations. The content in foundation studies and the school placement programme in teacher education programmes need to enable physics student teachers acquire effective communication skills. As Silver (2017) further noted, communication skills is key for teachers' delivery of content, classroom management and interaction within the classroom.

The Teaching Council (2011) reaffirms that content in physics teacher education should comprise foundation studies that include courses offered in curriculum studies, history and policy of education, philosophy of education, psychology of education, sociology of education and special needs education. Similarly, professional studies that involve courses in subject pedagogies, subject disciplines and courses in secondary school placement should be part of the content in any teacher education programmes. On the other hand, traditional teacher preparation in colleges and at universities has faced withering criticism in recent years as physics teachers are poorly prepared for teaching. This has been blamed partly on disjointed content and poor classroom practices, as teachers are not given the necessary tools to succeed in an environment where achievement is the fundamental goal (Levine, 2006). In contributing towards Levine's assertions, Wiema (2007) argues that traditional education focused on learning of subject matter content and on assessing the content knowledge using quizzes, tests and end of chapter questions. However, the desired outcomes in learning frameworks include learning the subject matter and complementary content themes, alongside inter- disciplinary themes. In such a case, the subject matter should be taught to physics teacher trainees with courses in financial literacy, health literacy, civil literacy, global awareness and environmental literacy (Robinson, 2009; Pacific Policy Research Centre, 2010).

4.3.4 Relevance of Content in Physics Teacher Education Programmes in Relation to Skills in use of Resource Materials by Student Teachers

Data on the relevance of content in physics teacher education programmes to acquisition of skills in use of resource material was also gathered from the student teachers. The data was further summarised in Table 20.

Table 20: Relevance of Content in Physics Teacher Education Programmes to Use of Resource Materials (Student Teachers, n= 351)

No	Content in Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Educational Media and Resources	211	116	12	12	0	4.50
2	Educational Technology	201	127	20	3	0	4.50
3	Instructional Technology & Media Practicals	132	128	80	7	4	4.07
4	Teaching Practice	207	144	0	0	0	4.59
5	Project Work while on Teaching Practice	181	129	33	8	0	4.38
	Overall mean						**4.17**

KEY:

VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant).

Table 20 indicates that content in physics teacher education is relevant (*MS* = 4.17) to acquisition of skills in use of resource material by the student teachers. Furthermore, the extent to which the physics student teachers used resource materials in physics instruction was also determined in the current study. Findings are summarised in Table 21.

Table 21: Use of Resource Materials by Student Teachers in Secondary School Physics Instruction (Heads of Physics Subject, n = 225)

No	Item	VG *f*	Good *f*	Average *f*	Poor *f*	VP *f*	*MS*
1	Selection of resource material	11	32	148	26	8	3.05
2	Preparation of teaching aids	47	101	60	15	2	3.78
3	Use of physics models	24	39	130	29	3	3.23
4	Improvisation in teaching of physics	1	7	38	144	35	2.09
5	Utilization of physics laboratory equipment	39	36	102	39	9	3.25
6	Use of resources to cater for students with learning disabilities	1	11	17	160	36	2.03
	Overall mean						**2.91**

KEY:
MS – Mean Score (1.00 to 2.49 Poor, 2.50 to 3.50 Average while 3.51 to 5.00 Good)

Table 21 shows that student teachers were average (*MS* = 2.91) in use of resource materials in physics instruction. It can also be noted that student teachers were good at preparation of teaching aids (*MS* = 3.78) while poor at improvisation in physics (*MS* = 2.09). These findings were explained by data collected through a critical analysis of completed TPAD tools where one of the performance gaps identified in physics instruction was the lack textbooks to guide improvisation (see Appendix H) and such a remark indicates that physics teachers require training to enhance creativity and improvisation.

Findings of the current study which show that student teachers are good at preparation of teaching aids differ from those in a study conducted by Aina (2013) that looked at improvisation of instructional material and implications on teaching and learning of physics in Kwara state in Nigeria. In the study by Aina, it was established that there was inadequate preparation and use of instructional material in teaching physics. Moreover, the findings of the current study that student teachers were poor at improvisation of instructional material agree in part with the findings by Aina (2013) that revealed inadequate use of available material to improvise teaching aids in teaching of physics in Nigeria.

Resource materials in teaching of secondary school physics include objects that are commercially acquired or improvised by the teacher to make abstraction more concrete and practical to the learners (Okwelle, 2014). Okeke and Okeye (2013) have categorised resource materials into three broad groups as first, projected and electronic material such as radio, slide, overhead projectors and computer instruction system. The second group comprise non projected material that include printed or textual, charts and chalkboards while the third category is made up of manipulative material that the learner handles skilfully and expertly to bring the desired changes such as laboratory apparatus and equipment. And as Shamija (2005) has noted, when resources are appropriately utilised, learning is made concrete, real, immediate and permanent.

In contributing towards the debate on improvisation in physics classrooms, Sullivan (2010) has noted that, in today's education, citizens and institutions demand that classroom instructions increase learning effectiveness. In particular, higher education institutions must expand their repertoires to include active learning approaches that challenge students to be responsible for their learning. Sullivan identifies one such way as to get students to connect actively through improvisation with the material they need to learn. These sentiments are shared with Aina's (2013) assertions that as good as improvisation must be in teaching and learning of physics, if learners do not take part in the process of improvisation, then its aim may not be fully achieved, at the same time, there is need to address accuracy and precision of the improvised material. And as Olagunju and Abiona (2008) have recommended, physics teachers should be able to improvise, produce and use both material and ideas to aid instruction at all times. Moreover, issues that could aid adequate training of teachers in production and utilization of resources need to be addressed through the content of physics teacher education programme.

4.3.5 Relevance of Content in Physics Teacher Education Programmes in Relation to skills in use of Information Technology by Student Teachers

Relevance of content in physics teacher education programmes to acquisition of skills in use of information technology was established in the current study where data was collected from student teachers and summarised in Table 22.

Table 22: Relevance of Content in Physics Teacher Education Programmes to Acquisition of Skills in Use of Information Technology (Student Teachers, n= 351)

No	Content in Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Introduction to Computers	191	78	52	22	8	4.20
2	Introduction to Spread sheets and Databases	18	122	131	68	12	3.19
3	Information Systems Analysis and Design	8	12	108	185	38	2.34
4	Web Design and Publishing	2	18	92	159	80	2.15
5	Database Systems	0	32	67	170	82	2.14
6	Management Information Systems	10	41	138	111	51	2.56
7	Internet Computing	72	100	151	22	6	3.59
8	Multimedia Graphics	7	62	142	116	24	2.75
9	Electronic Commerce	0	8	141	30	172	1.96
10	Statistical Analysis with SPSS	2	58	73	152	66	2.37
11	Information Technology and Society	47	152	108	38	6	3.87
12	Human Computer Interactions (HCI)	9	112	121	79	30	2.97
13	Information Systems Application	2	19	77	178	75	2.13
14	Internet Control and Security issues	51	121	99	61	19	3.35
	Overall Mean						**2.83**

KEY:

VR – Very Relevant, R – Relevant, NS – Not Sure, I – Irrelevant, VI – Very Irrelevant, MS – Mean Score (1.00 to 2.49 =irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

Table 22 reveals that student teachers were not sure (*MS* = 2.83) of the relevance of content in physics teacher education programmes to acquisition of skills in use of Information Technology (IT). Further, Introduction to Computers (*MS* = 4.20), Information Technology and Society (*MS* = 3.87) and Internet Computing (*MS* = 3.59) were found to be relevant to acquisition of skills in use of IT whereas the following courses were found to be irrelevant; Electronic Commerce (*MS* = 1.96), Information Systems Application (*MS* = 2.13), Database Systems (*MS* = 2.14), Web Design and Publishing (*MS* = 2.15) and Information Systems Analysis and Design (*MS* = 2.34). This implies that there in need to relook at content that is deemed irrelevance as it may be contributing little to acquisition of skills in use of information technology by the physics student teachers. More data on how the student teachers utilised information technology in secondary school physics instruction was collected from heads of physics subject in secondary school and presented in Table 23.

Table 23: Use of Information Technology by Student Teachers in Secondary School Physics Instruction (Heads of Physics Subject, n = 225)

No	Item	VG *f*	Good *f*	Average *f*	Poor *f*	VP *f*	*MS*
1	Use of IT in Teaching Physics	18	58	34	60	55	2.66
2	Use of IT in assessment of Physics	6	32	83	67	37	2.57
3	Use of IT in developing physics project work	1	11	17	154	42	2.00
	Overall Mean						**2.41**

KEY:
MS – Mean Score (1.00 to 2.49 = Poor, 2.50 to 3.50 = Average while 3.51 to 5.00 = Good)

Table 23 indicates that student teachers were poor (*MS* = 2.41) in use of information technology in physics instruction. These findings creates a need for content in physics teacher education to focus more or content that are relevant for effective physics instruction that include introduction to computers, introduction to spread sheets and databases, internet computing and information technology and society

More data was collected through analysis of documentary evidence where it was noted that one of the key competency areas for teaching in secondary schools, as identified by the Teacher Performance Appraisal and Development Tool (TPAD), is the ability to integrate technology in the teaching and learning process (TSC, 2016). Sentiments that had earlier been made by the Pacific Policy Research Centre (2010) that the 21st century skills for students and teachers should focus on the need to utilise Information Technology (IT) in teaching. The Pacific Policy Research also noted that IT transforms learning, the nature of how we work and the meaning of social relationships, shared decision making and information sharing in the competency-based environment.

Recent efforts in curriculum reforms in Kenya have experienced challenges such as lack of capacity for teachers to implement a competency-based curriculum (Jwan, 2016). This was more so in the area of use of information technology in teaching hence the need for physics teacher education programmes to link the use of information technology in delivery of physics content. As Caruso and Kvarik’s (2005) and Wiema (2007) have observed, Information Technology (IT) enables users to produce and share content effectively, and in support of Caruso and Kvarik’s views, Laurillard (2009) has argued that computer based learning environments can work to stimulate student learning besides enabling users to become creative and engage in practices that challenge traditional relationships between teachers and students.

Furthermore, in any teaching episode, teacher education included, integration of technology in the discipline is very important. Moreover, Niess (2005) has asserted that few teachers have been taught to teach their subject matter with technology and therefore, the way teachers learned their subject matter is not necessarily the way students should be taught. Such sentiments were also made by Rosenthal (2000) that 20% of public school teachers in USA felt uncomfortable with the use of information technology in teaching. It is therefore important that lack of integration of information technology in the content of physics teacher education programmes is addressed, because this will enable student teachers internalise the critical role of IT in delivery of the secondary school physics content.

Rosenthal (2000) has pointed out the existence of gaps in teacher education that include teachers learning much about technology outside both the development of their knowledge on subject matter, and the development of their knowledge on teaching and learning. Rosenthal further suggests that, for technology to become an integral component or tool for learning, physics pre-service teachers must develop an overarching conception of their subject matter with respect to technology and what it means to teach with technology. In support of these views, Duhaney (2001) asserts that integration of technology in all courses in the teacher preparation programmes should be considered in order to be more supportive of the technology-enhanced pedagogical content knowledge and content specific applications. Technology therefore needs to be integrated in the content of physics teacher education programmes at all levels to enable physics student teachers model the same in secondary school physics instruction.

More importantly, literature on the use of information technology in training of physics teachers is mostly developed towards the cognitive domain of human learning (Mishra and Koehler, 2007; Angeli and Valanides, 2009) and identify the following elements that should guide development of physics teacher training programmes: technology knowledge, content knowledge, technological content knowledge, technological pedagogical knowledge and technological pedagogical content knowledge, with the latter being highly recommended in the training of physics teachers. Technological pedagogical content knowledge of physics teachers should be developed during the training as it connects the teacher's understanding of the content, pedagogy and technology and offers a practical fusing of the cognitive domain into technology integration, with a student-centred and inquiry-based perspective.

This assertion by Mishra and Koehler (2007) alongside those of the current research on the need to integrate information technology in delivery of physics knowledge agrees with those of earlier research done by Bryan (2006) that developed guidelines for effective use of technology in science education. Bryan outlined that technology should address worthwhile science within appropriate pedagogy and further presented technology products available for use in physics instruction. The range of products included computer generated models that are available in virtually all areas of physics.

The findings of the current research point to the need to integrate information technology in delivery of physics content in both physics teacher education programmes and in secondary school physics instruction. It is important that use of computers and other information technology devices in delivery of physics content are included in physics teacher education programmes. For instance, Damian, Russell & Laura (2004) advocated for the use of both conceptual models that seek to simplify concepts and phenomenological computer models that seek to represent a situation as realistically as possible. Rios and Madhavan (2002) have advocated for the inclusion of word processing programme in teacher training programmes while Wiema and Perkins (2005) have argued that spread sheets should be included in physics teacher education programmes because of their use in analysis of data and for their visual representation. Web technologies can also be a useful source of information on physics tutorials and in diagnostic self-assessment of students.

In discussing content of science education in the 21st century, Wiema (2007) advocates for the need to inculcate ability to articulate thoughts and ideas, listen effectively, communication effectively and that content in physics teacher education programmes be enhanced to enable teachers work in a set up with people of diverse abilities and talents. These assertions were supported by Trilling and Fadel (2009) that 21st century critical learning and innovation skills should be part of content in physics education programme. Similarly, there is need to incorporate life and career skills that are essential for teachers to work more effectively and with diverse teams in the content of physics teacher training programmes. This is to enable the teachers to be open minded to varying ideas and values, set and meet goals, be more accountable to stakeholders and to demonstrate ethical practices (Metiri Group & NCREL, 2003). Laurillard, (2009) has equally emphasized the need for content in physics teacher education programmes to address technological literacy of the trainees at all levels.

4.4 Relevance of Methods of Teaching in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

The relevance of methods of teaching in physics teacher education programmes of public universities in relation to pedagogic skills by student teachers was established. This was guided by Tyler's (1949) model that seeks to establish, how should the learning experiences in an educational programme be organised to increase the cumulative effect? Data was collected from physics student teachers, heads of physics subject in secondary schools where the student teachers were undertaking their teaching practice and from the physics teacher trainers. More data was also gathered through analysis of documents that included the KICD physics teaching syllabus, KNEC physics syllabus and the TPAD tool.

4.4.1 Relevance of Method of Teaching in Physics Teacher Education Programmes in Relation to Subject Matter Knowledge of Student Teachers

Data on the relevance of methods of teaching in physics teacher education programmes to acquisition of subject matter knowledge by the physics student teachers was collected and findings summarised in Table 24

Table 24: Relevance of the Methods of Teaching in Physics Teacher Education Programmes to Acquisition of Subject Matter Knowledge (Student Teachers, n= 351)

No	Methods of Teaching in Physics Teacher Education Programmes	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Lecture method	68	89	97	97	0	3.36
2	Interactive lecture	138	167	46	0	0	4.26
3	Experimentation	182	162	7	0	0	4.50
4	Laboratory reports	109	200	17	19	6	4.10
5	Project work	112	161	78	0	0	4.10
6	Students demonstration	16	23	175	130	7	2.08
7	Teacher demonstration	107	212	32	0	0	4.21
	Mean Score						**3.80**

KEY:
VR – Very Relevant R - Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

Table 24 indicates that methods of teaching in physics teacher education programmes are relevant (*MS* = 3.80) to acquisition of subject matter knowledge, and therefore, these methods of teaching needs to be upheld in physics teacher education programmes. However, it can be noted that students' demonstration (*MS* = 2.08) was deemed irrelevant in acquisition of subject matter knowledge. The frequency with which physics teacher trainers use the methods of teaching in the training process of the student teachers was also established and findings summarised in Table 25.

Table 25: Frequency of Use of Methods of Teaching in Physics Teacher Education (Physics Teacher Trainers, n= 108)

No.	Methods of teaching	VF *f*	F *f*	NS *f*	R *f*	VR *f*	*MS*
1	Lecture Method	72	27	7	0	0	4.60
2	Interactive Lecture	55	30	18	2	2	4.22
3	Experimentation	12	15	43	22	16	2.86
4	Student Demonstration	8	9	14	31	46	2.09
5	Teacher Demonstration	12	16	24	18	38	2.50
6	Laboratory Reports	19	29	32	10	18	3.20
7	Research Reports	64	38	6	0	0	4.54
8	Project Work	51	32	17	3	5	4.11
9	Group Work	74	18	7	6	3	4.43
10	Use of Chalk Boards	32	22	7	38	9	3.28
11	Charts and Tables	53	33	17	4	1	4.23
12	Use of Models to cater for students with learning disabilities	6	19	13	8	62	2.06
13	Students Demonstration	21	8	23	32	24	2.72
14	Peer Teaching	11	9	22	48	28	2.34
15	Use of IT in teaching	21	25	18	34	10	3.12
	Overall Mean						**3.14**

KEY:

VF – Very Frequently used F – Frequently used NS – Not Sure R – Rarely Used VR – Very Rarely used**.** MS – Mean Score (1.00 to 2.49 = Rarely Used, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Frequently Used

Table 25 shows that the most frequently used methods of teaching in physics teacher education programmes are lecture method (*MS* = 4.60), research reports (*MS* = 4.54), group work (*MS* = 4.43), use of charts and tables (*MS* = 4.23) and interactive lecture (*MS* = 4.22). On the other hand, the use of models to cater for students with learning disabilities (*MS* = 2.06), student demonstration (*MS* = 2.09) and peer teaching (*MS* = 2.34) were rarely utilised in physics teacher education programmes. These findings implies that student teachers may not be equipped with skills in use of teaching models that caters for students with learning disabilities, student demonstration and peer teaching from the training they have undergone at the universities.

Further, information gathered from the open-ended questions revealed that physics Teacher Trainers suggested that student centred approaches and associated assessment strategies should be enhanced, as some of the improvements that should be made on methods of teaching in physics teacher education programmes. The exact excerpts from the Teacher Trainers (TT) were as follows:

> *Teacher Trainer 64: "Courses offered in physics should advance the use of experimentation and other student centred methods"*

> *Teacher Trainer 72: There is need to incorporate inquiry based methods and also formative assessment in the course work"*

Contextually, the excerpts refer student centred approaches such as the use of interactive lecture, experimentation and project. Similar findings were made in a study conducted by Marcelo and Marina (2014) that sought to evaluate the professional formation of prospective physics teachers in Brazil with emphasis on teaching methodology. In the study, it was concluded that there was need to shift education from the approaches that focus on transmission of content to those that address students' needs. This was because the student centred approaches were understood to be effective in the development of cognitive and social skills.

A critical analysis of documentary evidence was also conducted and it was noted that no guidelines on the use of methods of teaching were specified in both the Kenya Institute of Curriculum Development (KICD) physics teaching syllabus, and the Kenya National Examination Council (KNEC) syllabus. Rather, teaching approaches such as the experimentation and project work are listed at the end of the syllabus layout and teachers asked to use them. This is regardless of lack of information on particular content areas that each approach is most effective. This called for a scrutiny of methods of teaching that were utilised by the physics student teachers in secondary school physics instruction, and data collected from heads of physics subject in the secondary schools where the student teachers were undertaking their teaching practice is summarised in Table 26.

Table 26: Frequency of Use of the Methods of Teaching in Relaying Subject Matter Knowledge in Secondary School Physics Instruction (Heads of Physics Subject, n =225

No	Use of Methods of Teaching	V.F *f*	F *f*	NS *f*	R *f*	V.R *f*	*MS*
1	Lecture method	58	115	43	9	0	3.99
2	Interactive lecture	29	62	132	2	0	3.52
3	Experimentation	77	49	86	8	5	3.82
4	Laboratory reports	1	16	31	112	65	2.00
5	Project work	8	16	41	92	68	2.13
6	Use of a variety of strategies in teaching	26	11	86	67	35	2.67
7	Student demonstration	0	12	93	108	12	2.47
8	Teacher demonstration	51	88	63	18	5	3.72
9	Use of question and answer method	66	82	70	7	0	3.92
10	Use of models to cater for students with learning disabilities	0	11	32	122	60	1.97
11	Level of engagement in manipulative skills	53	59	74	31	8	3.52
	Overall Mean						**3.07**

KEY:
VR – Very Frequently F – Frequently NS – Not Sure R – Rarely VI – Very Rarely MS – Mean Score (1.00 to 2.49 = Rarely Used, 2.50 – 3.50 = Not Sure while 3.51 - 5.00 = Frequently Used)

Table 26 indicates that heads of physics subject were not sure (*MS* = 3.07) of the extent to which the student teachers used methods of teaching in secondary school physics instruction. It can also be noted that student teachers frequently used lecture method (*MS* = 3.99), question and answer approach (*MS* = 3.92), experimentation (*MS* = 3.82), teacher demonstration (*MS* = 3.72) and interactive lecture (*MS* = 3.52). On the other hand, student teachers were found to have rarely used models that cater for students with learning disabilities (*MS* = 1.97), laboratory reports (*MS* = 2.00), project work (*MS* = 2.13) and student demonstration (*MS* = 2.47).

Findings in Table 24 and those in Table 26 reveal that student teachers are conscious of the need to use student centred methods in teaching physics, but they are unable to practice and secure the full benefits of these methods, such as the use of interactive lecture, experimentation, laboratory reports and project work. These findings are similar to those of the study conducted by Collins, Brown & Newman (1989); Simmons, Emory, Carter, Coker, Finnegan & Crocket (1999) and Etkina (2015) that student - centred teaching is yet to be made a habit by new teachers as many teachers experience difficulty implementing it despite the teachers being taught about their importance.

On the other hand, Conant (1963) noted that some teachers who rarely use student centred approaches in many cases opt for the traditional lecture approach which does little to aid in learning of physics concepts. In support of Conants' views, Couso (2009) indicated that when lecture approach is the chosen or necessary teaching method, a teacher should be empowered to avoid direct repetition of material in a text book. This will enable the teacher to remain a useful alternative resource. Moreover, the teacher should be able to use paradoxes, puzzles and apparent contradictions to engage students. The teacher should equally plan to link concepts to current events and every day phenomena and also address the curiosity of learners. Methods of teaching used in physics teacher education should be such that it enhances the ability of the student teachers to always enrich lecture method as it is one of the preferred methods of teaching by the physics student teachers. Most importantly, there is need to practice student centred approaches to instruction in physics teacher education and equip the trainees with a variety of teaching strategies associated with inquiry based learning. This way, the capacity of the student teachers in conducting secondary school physics instruction will be improved upon.

The findings of the current study are also in agreement with Etkina's (2015) recommendations that physics teacher preparation should enable pre-service teachers to learn content through the pedagogy that the teachers are to use in secondary school teaching. In light of Etkina's assertion, it is important that development of methods of teaching in physics teacher education be informed by teaching demands in secondary school physics. For instance, McFarland (2005) noted that lecture demonstration is helpful in promoting student learning as it provides evidence for the concepts learned and forms a concrete and visual way of explaining a concept. In support of Etkina`s assertion, Miller (2012) argued that, by using demonstration as a teaching method, the teacher is replaced from being a source of knowledge and the teacher offers more guidance as students become more creative, work collaboratively and even respect diversity. The use of lecture demonstrations should equally be enhanced in training of physics teachers.

4.4.2 Relevance of Method of Teaching in Physics Teacher Education Programmes in Relation to Assessment Skills of Student Teachers

Data collected from student teachers on the relevance of the methods of teaching in physics teacher education programmes to acquisition of assessment skills is shown in Table 27.

Table 27: Relevance of the Methods of Teaching in Physics Teacher Education Programmes to Acquisition of Assessment Skills (Student Teachers, n= 351)

No	Methods of Teaching in Physics Teacher Education Programmes	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Lecture method	8	53	204	81	5	2.94
2	Interactive lecture	83	101	158	9	0	3.74
3	Experimentation	101	208	42	0	0	4.17
4	Laboratory reports	100	123	78	50	0	3.78
5	Project work	62	153	100	36	0	3.69
6	Students demonstration	3	28	136	82	102	2.28
7	Teacher demonstration	122	120	88	21	0	3.98
	Mean Score						**3.51**

KEY:
VR – Very Relevant R - Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

Table 27 shows that methods of teachings in physics teacher education programmes are relevant (*MS* = 3.51) to acquisition of assessment skills apart from students demonstration (*MS* = 2.28) which was deemed irrelevant. This indicates that emphasis should be placed on the use of interactive lecture, experimentation, use of laboratory reports and the uses of project work in physics teacher education programmes for acquisition of assessment skills by the student teachers.

Qualitative data was also scrutinised and remarks made by student teachers on improvements that should be made on methods of teaching in physics teacher education that were considered. Some of the statements made were as follows:

Student teacher 81: "We should be allowed to ask many questions. We always follow the procedures given in practicals so as to clear the Courses on time"

These sentiments are evidence of difficulties experienced by physics student teachers especially in handling the stages of experimentation both in their training and teaching of physics in secondary schools. Furthermore, analysis of the Kenya National Examination Council (KNEC) physics syllabus reveals that learners should have skills and knowledge in conducting experimental work as it contributes to 40% of the learners' achievement in physics. However, the KNEC syllabus does not indicate the stage at which students work sample can be assessed, but rather it is more summative. Similar gaps were noted with the Kenya Institute of Curriculum Development physics teaching syllabus where strategies to be used in assessing laboratory work were lacking. It is therefore important that physics teacher education takes the leadership role necessary for effective assessment in secondary school physics. This is by equipping the teacher trainees with a variety of assessment strategies especially in experimental work and also by allowing the student teachers to practise with assessment models that can be used in laboratory processes.

Marcelo and Marina (2014) established that despite the importance of experimentation, physics introductory laboratories fail to convey the excitement of discovery to majority of students. Students therefore describe them as boring or a waste of time. Marcelo and Marina concluded that many laboratory programmes suffer neglect where students work their way through a list of step-by-step instructions trying to reproduce expected results and wondering how to get the right answer. Similarly, Ayeni (2010) has argued that the role of a teacher is crucial for effective and efficient learning as the teacher is expected to provide essential inputs that include proper monitoring and assessment of students' performance.

In contributing to the debate on methods of teaching and associated assessment practices in physics instruction, Couso (2009) has argued that oral presentation to large groups of passive students contribute very little to real learning. He further asserts that this is more so in physics where standard lectures do not help most students develop conceptual understanding of fundamental processes. Couso further argued that appropriate assessment tools need to be employed at all levels of a standard lecture as a way of testing students' understanding of the concepts. It is important therefore that methods of teaching in physics teacher education should enable student teachers manage all the stages of experimentation and assessment of experimental work effectively. It should also enable student teachers to conduct more meaningful and enriched instruction whenever lecture approach is used.

4.4.3 Relevance of Method of Teaching in Physics Teacher Education Programmes in Relation to communication Skills of Student Teachers

The study further sought to establish the relevance of methods of teaching in physics teacher education programmes in relation to communication skills of student teachers and the findings are presented in Table 28.

Table 28: Relevance of the Methods of Teaching in Physics Teacher Education Programmes to Acquisition of Communication Skills (Student Teachers, n= 351)

No	Methods of Teaching in Physics Teacher Education Programmes	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Lecture method	28	29	71	161	62	2.43
2	Interactive lecture	110	201	26	14	0	4.16
3	Teacher demonstration	78	66	70	37	100	2.96
4	Student demonstration	32	98	114	71	36	3.05
5	Group work	126	180	44	1	0	4.23
6	Use of models to cater for students with learning disabilities	58	89	125	67	12	3.32
7	Peer Teaching	28	46	147	81	49	3.97
	Mean Score						**3.45**

KEY:
VR – Very Relevant R - Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

Table 28 shows that methods of teaching in physics teacher education are relevant (*MS* = 3.45) to acquisition of communication skills by the student teachers and therefore the methods should be utilised in physics teacher education programmes. More data on the use of methods of teaching by the student teachers in enhancing communication in secondary school physics instruction was also collected from the heads of physics subject in secondary schools and summarised in Table 29.

Table 29: Frequency of use of Methods of Teaching in Relaying Communication Skills in Secondary School Physics Instruction (Heads of Physics Subject, n =225)

No	Methods of teaching	V F *f*	F *f*	NS *f*	R *f*	VR *f*	*MS*
1	Lecture method	78	115	32	0	0	4.20
2	Interactive lecture	29	52	68	64	12	3.10
3	Use of a variety of strategies in teaching	22	63	86	37	17	3.16
4	Student demonstration	0	12	43	85	85	1.92
5	Teacher demonstration	47	71	90	12	5	3.64
6	Use of question and answer method	55	62	70	37	1	3.59
7	Use of models to cater for students with learning disabilities	0	2	24	122	77	1.78
	Overall Mean						**3.06**

KEY:
VR – Very Frequently F – Frequently NS – Not Sure R – Rarely VI – Very Rarely MS – Mean Score (1.00 to 2.49 = Rarely Used, 2.50 – 3.50 = Not Sure while 3.51 - 5.00 = Frequently Used)

Table 29 shows that student teachers were average (*MS*= 3.06) in use of teaching methods that enhance communication in secondary school physics instruction. Further, student teachers were noted to have frequently used lecture method (*MS* = 4.20), teacher demonstration (*MS* = 3.64) and in use of question and answer method (*MS* =3.59) while student teachers rarely used models that cater for students with learning disabilities (*MS* = 1.78) and students' demonstrations (*MS* = 1.92). Therefore there is need for physics teacher education to enhance the use of models to cater for students with learning disabilities and the use of student demonstrations in order to enable the student teacher apply the same in secondary school physics instruction.

As much physics student teachers indicated that lecture method was irrelevant to acquisition of communication skills in as in Table 28, Table 29 shows that the student teachers frequently use lecture method in teaching of secondary school physics. The findings appeared contradictory and therefore the need to address the overuse of lecture method in secondary school physics instruction that emanates from the frequent use of lecture method in physics teacher education programmes.

On reporting on the key factors that need to be better understood in training of physics teachers, Couso, (2009) identified the need to learn content, learning to teach what one knows and being able to pass the content to the students. There is need for physics teacher education programmes to emphasise on use of interactive approaches to teaching at all levels of the process rather than utilise the methods sparingly as revealed in the current research. In outlining the failings of traditional education practices, Wiema (2007) suggests that methodology in science teaching and learning, physics included, should incorporate specific data driven approaches to make science education effective and relevant to a larger and diverse population.

Marcelo and Marina (2014) further established that peer instruction methods may be an effective tool for preparing future teachers and enabling them deal with methodological aspects in the context of curricular innovation. Borrowing from the findings of the current study and from Marcelo and Marina’s assertions, it can be argued that teacher education programmes that embrace student-centred and peer instruction approaches enable the student teachers model the approaches in secondary school physics instruction.

On classroom demonstrations, Etkina (2015) has discussed that demonstrations can be effective for illustrating concepts in physics and can challenge students to think for themselves especially if the demonstration has surprises, challenges an assumption or illustrates an otherwise abstract concept. However, teacher demonstrations can result in passive learning and teachers should endeavour to engage students through questioning and also direct students to conduct some of the demonstrations. Methods of teaching in physics teacher education programmes should equip the student teachers with relevant skills in use of well thought out questions that motivate and direct learners' observations before, during and after demonstrations.

Moreover, people differ in their social proficiency and the quality of one's communicative performance has significant impact on professional and personal success (Adeyemi, 2016). Proficient communicators receive information, synthesise the information to understand it and express themselves well (Silver, 2017). As John has further noted, teachers should be effective communicators that can analyse what learners need to be able to do after instruction and review what learners are already able to do prior to instruction. Effective communication for a teacher also entails good presentation skills in the transmission of a message that involve a shared understanding between the teacher, students and generally all the stakeholders in education. Physics teacher education programmes should therefore enable the student teachers determine whether learners are actually implementing the target skills after instruction, and follow up to ascertain the impact of the target skills on learning outcomes.

The policy framework for education for all Kenyans by 2015 (GoK, 2005) envisage raising 100% transition rate from primary school to secondary schools. The framework also focuses on improving the relevance and quality of education in all secondary schools so as to increase equity with regard to achievement. The concept of education for all may see an increase in the numbers of students with learning disabilities in the mainstream physics classrooms. As Richard and Thousand (2016) have observed, widespread inclusion practices will always lead to a large percentage of students with documented learning disabilities getting into science classrooms. These students may be deficient in certain aspects of learning such as organisation, reading, writing and memory. However, Richard and Thousand have further recommended that, regardless of race, gender or disability, students should have an opportunity to learn and understand the essential content in physics. This can only be made possible when teachers are conscious to the existence of students with learning disabilities and understand the need to utilise diverse strategies that offer multiple representation of physics content. However, the current research revealed lack of sufficient practice in both physics teacher education programmes and in secondary school physics instruction towards use of relevant teaching models and methods in order to address the needs of students with learning disabilities.

4.4.4 Relevance of Method of Teaching in Physics Teacher Education Programmes in Relation to Skills in use of Resource Materials by Student Teachers

In light of relevance of methods of teaching in physics teacher education programmes in relation to skills in use of resource materials by student teachers, data on the relevance of methods of teaching in physics teacher education programmes to acquisition of skills in use of resource materials was collected from student teachers are represented in Table 30.

Table 30: Relevance of Methods of Teaching in Physics Teacher Education Programmes to Acquisition of Skills in Use of Resource Material (Student Teachers, n= 351)

No	Methods in Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Interactive lecture	110	201	26	14	0	4.16
2	Teacher demonstration	198	106	30	17	0	4.38
3	Student demonstration	68	32	114	101	36	2.99
4	Group work	126	180	44	1	0	4.23
5	Use of models to cater for students with learning disabilities	56	118	125	29	23	3.44
6	Peer Teaching	82	76	97	47	49	3.27
	Mean Score						**3.75**

KEY:
VR – Very Relevant R - Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

From Table 30, it is evident that methods of teaching in physics teacher education programmes are relevant (*MS* = 3.75) to acquisition of skills in use of resource materials. Data on the preparedness of physics student teachers on the use of resource materials in secondary school physics instruction was also collected from physics teacher trainers. The trainers were drawn specifically from the departments of Educational Communications, Technology and Curriculum Studies that is responsible for the training of teachers on design and use of resource materials and the data gathered is represented in Table 31.

Table 31: Preparedness of Physics Student Teachers on use of Resource Materials (Physics Teacher Trainers, n = 21)

No	Preparedness of student teachers	HP	P	NS	U	VU	*MS*
1	Selection of resource materials	5	10	6	0	0	3.95
2	Use of resource materials	2	9	7	3	0	3.47
3	Preparation of teaching aids	4	4	12	1	0	3.52
4	Use of physics models	2	8	7	3	1	3.33
5	Use of resources to cater for students with learning disabilities	0	2	7	8	4	2.33
	Overall Mean						**3.32**

KEY:
HP – Highly Prepared P - Prepared NS – Not Sure U – Unprepared VU – Very Unprepared MS – Mean Score (1.00 to 2.49 = Unprepared, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Prepared)

Table 31 further indicates that physics teacher trainers were not sure *(MS= 3.32*) of the preparedness of the student teachers on use of resource materials. The Table also reveals that student teachers were prepared in selection of resource materials *(MS = 3.95)* and in preparation of teaching aids *(MS = 3.52)* while they were unprepared in the use of resources to cater for students with learning disabilities *(MS = 2.33)*. There is therefore need for physics teacher education programmes to adequately prepare student teachers on use of resource material for effective secondary school physics instruction.

Findings from previous research encourages teachers and educational stakeholders to focus on real world problems and processes, support inquiry based learning experiences and provide opportunity for collaborative projects and the use of information technology (Darling-Hammoud, 2008). It is expected that better teaching and learning in secondary school physics can be achieved through careful selection, development and skilful utilization of appropriate instructional material (Okeke & Okeyo, 2013). Teachers should also be in a position to consider improvisation of material and equipment in cases where the cost of purchase is out of reach. Moreover, improvisation increases inquiry, curiosity, creativity and productive application of intellect and therefore necessary in enhancing of physics teachers' manipulative skills.

The revelation of limited improvisation in secondary school physics instruction in the current study may be evidence of inadequate skills and knowledge acquired by the student teachers during training on the control and use resource material in teaching in secondary schools. As Wiema (2007) has discussed, in order to make scientific approach to science teaching, a norm rather than just a set of experimental projects, change must first occur at the major research universities, because these institutions set the norm that pervade the education system regarding how science is taught. In contributing to Wiema's discussion, Aina (2012) argued that many of the equipment used in teaching of physics can be improvised and it is necessary for teachers to endeavour to utilise material around them to improvise there teaching. Similarly, learners are exposed to creativity, innovation and curiosity when they participate in improvisation of instructional material (Adenivan, 2006).

In the circumstance of limited improvisation in physics instruction as in the case revealed by the current study, Kira and Nchunga (2016) has identified two existing constraints to successful improvisation that include technical factors and human factors. Technical factors are centred on accuracy and precision with the improvised equipment while human factors surround the teachers' skills in developing the equipment and providing the appropriate learning experience to the learners. From the foregoing, physics teacher education programmes should consider addressing both the technical and human aspects to improvisation and equally entrench improvisation in the training of teachers. Training of physics teachers should therefore see to it that teachers are grounded on principles of the nature of knowledge and an understanding of educational models and the resources that support instruction.

4.4.5 Relevance of Method of Teaching in Physics Teacher Education Programmes in Relation to Skills in use of Information Technology by Student Teachers

In order to establish the relevance of methods of teaching in physics teacher education programmes in relation to skills in use of information technology by student teachers, data was first collected from the physics students on the relevance of methods of teaching and summarised in Table 32

Table 32: Relevance of the Methods of Teaching in Physics Teacher Education to Acquisition of Skills in Use of Information Technology (Student Teachers, n= 351)

No	Methods of teaching in Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	MS
1	Experimentation	248	75	28	0	0	4.63
2	Project work	207	107	36	1	0	4.48
3	Use of chalk boards	22	49	32	207	41	2.44
4	Charts and tables	84	74	117	46	30	3.39
5	Use of computer software	217	119	13	2	0	4.56
6	Use of projected slides	222	102	26	1	0	4.55
7	Use of computer simulations	212	91	48	0	0	4.47
8	Use of IT in teaching physics	176	129	36	10	0	4.34
9	Use of IT in assessment of physics	182	124	39	6	0	4.37
	Mean Score						**4.14**

KEY:
VR – Very Relevant R - Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

Table 32 shows that methods of teaching in physics teacher education programmes are relevant (*MS* = 4.14) to acquisition of skills in use of information technology. In addition, more data was collected from heads of physics subject from secondary schools where the physics student teachers were undertaking their teaching practice. This measured the frequency with which the student teachers used information technology in secondary school physics instruction and findings summarised in Table 33.

Table 33: Frequency of Use of Information Technology by Student Teachers in Secondary School Physics Instruction (Heads of Physics Subject, n = 225)

No	**Item**	**VF** *f*	**F** *f*	**NS** *f*	**R** *f*	**VR** *f*	***MS***
1	Use of computer software in physics instruction	11	65	32	101	16	2.79
2	Use of projected slides in teaching physics	0	7	11	112	95	1.69
3	Use of computer simulations in teaching physics	2	16	19	117	71	1.94
5	Use of IT in teaching physics	22	31	30	91	51	2.48
5	Use of IT in assessment of physics	28	20	47	77	53	2.52
	Overall Mean						**2.28**

KEY:
VR – Very Frequently F – Frequently NS – Not Sure R – Rarely VI – Very Rarely MS – Mean Score (1.00 to 2.49 = Rarely Used, 2.50 – 3.50 = Not Sure while 3.51 - 5.00 = Frequently Used)

Table 33 indicates that student teachers rarely used information technology (*MS* = 2.28) in secondary school physics instruction. Moreover, data collected from physics teacher trainers on the use of information technology in the training of physics teachers was equally collected and represented in Table 34.

Table 34: Frequency of Use of Information Technology in Physics Teacher Education (Physics Teacher Trainers, n = 108)

No	Item	VF *f*	F *f*	NS *f*	R *f*	VR *f*	*MS*
1	Use of computer software	23	52	29	2	2	3.85
2	Use of projected slides	11	15	29	50	3	2.82
3	Use of computer simulations	3	6	13	23	63	1.73
5	Use of IT in teaching	36	29	36	7	0	3.87
5	Use of IT in assessment	8	36	42	22	0	3.28
	Overall Mean						**3.11**

KEY:
VR – Very Frequently F – Frequently NS – Not Sure R – Rarely VI – Very Rarely MS – Mean Score (1.00 to 2.49 = Rarely Used, 2.50 – 3.50 = Not Sure while 3.51 - 5.00 = Frequently Used)

Table 34 shows that physics teacher trainers were not sure (*MS* = 3.11) of the use of information technology in physics teacher education programmes, and the Table further indicates that physics teacher trainers rarely used computer simulations (*MS* = 1.73). These findings imply that practices on use of information technology in physics teacher education programmes are replicated in secondary school instruction as conducted by the student teachers.

From the foregoing, in order to establish methods of teaching that should be emphasised in physics teacher education programmes for acquisition of pedagogic skills, combined data collected from student teachers and heads of physics subjects in secondary school was represented in Table 35.

Table 35: Methods of Teaching that should be Emphasised in Physics teacher Education Programmes (Student Teachers, n= 351; Heads of Physics Subject, n= 225)

No	Methods of Teaching	Student Teachers *f*	Physics Heads Of subjects *f*	Total *f* (%)
1	Interactive lecture	215	145	360 (62.5)
2	Experimentation	134	201	335(58.2)
3	Use of IT in teaching	187	143	330(57.3)
4	Project work	138	156	294(51.0)
5	Use of models to cater for students with learning disabilities	111	124	235(40.8)
6	Peer teaching	78	115	193(33.5)
7	Students demonstration	92	62	154(26.7)
8	Use of charts and Tables	67	74	141(24.5)
9	Lecture method	32	30	62(10.8)
10	Teacher demonstration	27	34	61(10.6)

Table 35 shows that methods of teaching that should be emphasised in physics teacher education programmes for acquisition of pedagogic skills include; Interactive lecture (62.5%), experimentation (58.2%), use of information technology in teaching (57.3%), use of project work (51.0 %) and the use of models that cater for students with learning disabilities (40.8%).

Findings of this study on methods of teaching that should be emphasised in physics teacher education programmes bring to the forefront the need for use of interactive approaches and inquiry-based teaching methods in physics instruction. These include interactive lecture, experimentation, use of information technology and project work. These findings are similar to those of a study conducted by Nurshamshida, Nabila and Nurlatila (2013) that aimed at developing science education pedagogies in Selangor Malaysia in which simulations, demonstrations, experiments, projects work and field studies were used by trainee teachers as teaching strategies. The study by Nurshamshida et al. revealed that such inquiry based strategies were able to stimulate excitement among students and were highly recommended in the physics classrooms. The study by Nurshamshida et al. recommended that prior to real teaching experiences, the pre-service teachers should be exposed to inquiry-based methods at college level. This is because pre-service teachers who are taught using inquiry based methods are more likely to develop hands on activities in their teaching (Plevyak, 2007). More so, such teachers are more likely to link science experiments with everyday life. Hands-on activities in physics classrooms can be enhanced when interactive lecture technique, experimentation and use of project work are emphasised in physics teacher education programmes.

Experimentation is key to doing investigation in the physics classroom. Experiments encourage students to learn physics by providing them with opportunities to manipulate objects, test hypotheses and collaboratively work together. While supporting the central role of experimentation in physics classrooms, Olympiou and Zacharia (2011) argued that the use of a blended combination of physical manipulative and visual manipulative processes enhanced student conceptual understanding in the major domains of physics knowledge.

In support of the need to intensify use of experimentation in teacher training and in secondary school physics instruction, Government of Kenya (2012) advocated for the use of instructional models and methods that promote the understanding of physics and anchored it on innovative use of technology such as active learning, discussion methods, inquiry based learning, demonstrations, collaborative learning, role play and use of project work. Similarly, the Teaching Council (2007) in developing the code of professional conduct for teaching, advocated for support structures for teachers in inclusion of students with special educational needs in the physics classroom. This can probably be achieved through use of methods of teaching that address varied learning needs of students. Similar recommendations are made by O'Leary (2008) that physics teachers should be made aware of the need for inclusion in the science classroom, understand criteria for creating inclusive environments, use of interactive presentations and teachers should also be guided on the choice of various accessible experiments to be used. Moreover, Colburn (2008) advocates for teacher education to draw on the universal design learning model, that emphasises use of multiple representation, engagement and assessment to enrich physics instruction for diverse learning.

The current study further revealed that information technology should be emphasised in physics teacher education programmes for acquisition of pedagogic skills needed for effective secondary school physics instruction. However, Table 33 had indicated that student teachers were poor at use of information technology in secondary school physics, findings that are similar to those in the study conducted by Anouk, Bart & Nyaga (2006) in which it was established that information technology equipment such as the computers are largely used as objects in computer lessons and rarely used in delivery of physics content. Furthermore, as O'Leary (2008) has noted, teachers who have undertaken courses in software packages are unable to integrate or meaningfully entrench the knowledge in their daily teaching. Concerns that had been earlier raised by Niess (2005) that pre-service teachers learn about teaching outside both the subject matter and technology hence technology remains unconnected with the subject matter. This calls for a shift in teacher education programmes towards embracing and developing the desired Technological Pedagogical Content Knowledge (TPCK). Niess equally argued that TPCK should include the use of knowledge in the curriculum and curriculum material that integrates technology with learning of the subject matter. Further, UNESCO (2012) has reported that teacher education may either assume a leadership role in the transformation of education, or be left behind in the swirl of rapid technological change.

Moreover, web technologies and collaborative computer based learning environments can be embraced in physics teacher education programmes as argued by Caruso and Kvarik (2005) that web technologies enable users to produce and share content in new ways and in real time. Web technologies also enable users to become creative and engage in practices that challenge traditional relationships between teachers and students, specifically in providing information and content for learning (White, 2008). While Laurillard (2009) has indicated that computer based learning environments can work to stimulate student learning, enhance the process of inquiry and can impact desirably on effective problem solving, critical thinking and information handling abilities. Benefits of computer based learning cannot be underestimated and therefore, it is necessary that physics teacher education programmes integrate relevant web technologies and computer based learning models to enable the student teacher use similar models in secondary school physics teaching.

Zahra and Ali (2014) have noted that teacher trainees need opportunities to practice effective technology integration strategies in methods courses and field experiences (Zahra and Ali, 2014). Technology training directly affects pre-service teachers' self-efficacy and value beliefs. This in turn, influences their student-centred technology use. As Laurillard (2009) has noted, despite the abstract nature of physics, its teaching is to bring about scientific thinking in students and enable students develop a mind-set that requires testing out ideas through experimentation. Through the use of information technology, the teaching and learning of physics is interesting and it offers a great variety of opportunities for modelling concepts and processes. Information technology also provides a bridge between students' prior knowledge and learning of new physical concepts and it helps students develop scientific understanding. Moreover, Shelly, Gunter and Gunter, (2012) have established that information technology can provide an appropriate medium for teachers to nurture higher level thinking in students.

Computers can be used for many purposes in teaching of physics with the most prevalent use of computers being word processing (Rios & Madharan, 2000) that comprise Microsoft word; slide show programmes such as Microsoft power point; spread sheet programmes such as Microsoft Excel and web page programmes that include Microsoft front page. it is thus important that word processing programmes are utilized in physics teacher education programmes together with other appropriate computer software in delivery of physics content both in training of teachers and in secondary school physics instruction. And as Otero, Johnson and Goldberg (1999) have asserted, the effectiveness of computer technology depends not only on the way in which computers and software are used, but also on the interaction of the students as they learn content using technology.

The current study further revealed that, as much as teaching strategies that cater for students with learning disabilities are relevant for acquisition of pedagogic skills of student teachers, such strategies were poorly used in secondary school physics instruction by the student teachers. In a similar situation where an increase in the number of students with learning disabilities in USA, the Illinois state university sought to review the methods of teaching in order to equip teacher trainees with knowledge and skills in the school laws, appropriate safely procedures, address issues related to diversity, inclusion of disabled and gifted students and also to distinguish between ethical and unethical behaviour (Rich & Brigham, 2006). Physics education programmes in Kenyan public universities should equally seek to equip student teachers with methods of teaching that address the diversity witnessed in the current secondary school classrooms, more so, the needs of students with learning disabilities. As Richard and Thousand (2016) and the University of Sydney (2018) have noted, integration of teaching methods for inclusion in instruction such as applying appropriate waiting time, use of multi-sensory instruction and the use of universal design for learning strategies should be focussed on during the training process of physics teachers.

4.5 Relevance of Assessment Strategies in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

This study also endeavoured to establish the relevance of assessment strategies in physics teacher education programmes in relation to pedagogic skills of student teachers. Findings from questionnaires for student teachers, heads of physics subject, physics teacher trainers and from documentary evidence is summarised under each of the pedagogic skills that include subject matter knowledge, assessment skills, communication skills, skills in use of resource material and skills in use of information technology. The results were discusses in line with Tyler's (1949) theory and specifically, to answer to the following question, how should the effectiveness of an educational program be determined?

4.5.1 Relevance of Assessment Strategies in Physics Teacher Education Programmes in Relation to Subject Matter Knowledge of Student Teachers

First and foremost, the relevance of assessment strategies in physics teacher education programmes was determined from the student teachers and findings shown in Table 36.

Table 36: Relevance of Assessment Strategies in Physics Teacher Education Programmes to Acquisition of Subject Matter Knowledge (Student Teachers, n= 351)

No	Assessment Strategies in Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Assessment by observation	102	101	60	60	28	3.54
2	Questioning	241	92	15	3	0	4.63
3	Use of laboratory reports	128	82	84	52	5	3.79
4	Use of Written tasks in assessment	296	12	41	1	1	4.71
5	Assessment of group work	143	132	45	30	1	4.10
6	Development of assessment items	214	102	17	12	6	4.44
7	Peer assessment	31	118	90	102	10	3.17
8	Students' self-assessment	37	106	66	68	74	2.90
9	Portfolio analysis	16	76	124	81	54	3.00
10	Project work	143	72	60	54	22	3.74
	Mean Score						**3.80**

KEY:
VR – Very Relevant R - Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 to 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

It is revealed in Table 36 that assessment strategies in physics teacher education programmes are relevant to acquisition of subject matter knowledge (*MS* = 3.80) by the physics student teachers and therefore the strategies should be upheld in teacher training.

Analysis of the Kenya Institute of Curriculum Development (KICD) physics teaching syllabus revealed that in assessment, emphasis is placed on the use of practical work, project work, oral questioning, use of quizzes and the use of written examinations as assessment strategies that should be used in secondary school physics. Similarly, assessment of practical work, use of quizzes and written examinations are emphasised in physics teacher education programmes. When the Kenya National Examination Council (KNEC) assessment syllabus was scrutinised, it was revealed that congruence on assessment strategies with those of the physics teacher education programmes was on assessment of practical work, oral questioning, use of quizzes and use of written examinations, while little was mentioned on the use of project work as an assessment strategy in physics teacher education programmes.

One of the core mandates of physics teacher education is to enable student teachers to acquire a variety of assessment skills that are relevant and can be used to ascertain secondary school students' understanding of physics knowledge. McFarlane (2005) has observed that assessment of students' skills and knowledge is essential to guide learning and provide feedback to student teachers on how well their learners achieve during instruction. While Jones and Alcock (2014) have argued that the ultimate purpose of assessment is to enable students assess themselves, the gradual increase of students' responsibilities for assessment is aimed at developing students' autonomy as lifelong learners. In support of Jones and Alcock's views, Sue and Michael (2014) advocate for the need to involve students in developing assessment criteria and on encouraging students' self-assessment, while Hoffman, Assaf and Paris (2001) assert that a variety of assessment strategies should be used in the training process of student teachers in order for teacher trainees to model the same in secondary school instruction.

Moreover, observation is a fundamental process skill in physics and the ability to make good observation with either the use of senses or instruments is essential in development of other skills such as communication, classifying, measuring, inferring and predicting (Harlen, 2010). Teacher education programmes should therefore endeavour to address the need for student teachers to acquire skills in assessment by observation for the need to guide accurate observations in secondary school physics instruction.

4.5.2 Relevance of Assessment Strategies in Physics Teacher Education Programmes in Relation to Assessment Skills of Student Teachers

In order to establish the relevance of assessment strategies in physics teacher education programmes in relation to assessment skills of student teachers, first, data on the relevance of assessment strategies in physics teacher education programmes to acquisition of assessment skills was collected from the student teachers and summarised in Table 37.

Table 37: Relevance of Assessment Strategies in Physics Teacher Education Programmes to Acquisition of Assessment Skills (Student Teachers, n= 351)

No	Assessment Strategies in Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Assessment by observation	102	106	74	36	33	3.59
2	Questioning	124	132	87	5	3	4.05
3	Construction of assessment items	139	96	41	62	13	3.81
4	Adoption of assessment items from previous examination	133	121	69	21	7	4.00
5	Written tasks in assessing students	144	134	62	9	2	4.17
6	Use of group work in assessment	139	77	114	18	3	3.94
7	Peer assessment	100	133	99	12	7	3.87
8	Students' self-assessment	56	104	124	41	26	3.35
9	Portfolio analysis	132	112	53	49	5	3.90
	Mean Score						**3.85**

KEY:
VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant
MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 – 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

Table 37 shows that assessment strategies in physics teacher education programmes are relevant (*MS* = 3.85) acquisition of assessment skills by the student teachers, implying that, the assessment strategies should be utilised in physics teacher education programmes. Furthermore, use of written tasks in assessment (*MS* = 4.17), questioning (*MS* = 4.05), use of group work in assessment (*MS* = 3.94), portfolio analysis (*MS* = 3.90) and peer assessment (*MS* = 3.87) were revealed to be the most relevant assessment strategies in physics teacher education programmes for acquisition of assessment skills. Therefore, these strategies need to be used more often in physics teacher education. More data on use of assessment strategies in physics instruction was collected from heads of physics subjects and findings are represented in Table 38.

Table 38: Frequency of Use of Assessment Strategies by Student in Secondary School Physics Instruction (Heads of Physics Subject, n = 225)

No	Item	VF *f*	F *f*	NS *f*	R *f*	VR *f*	*MS*
1	Use of end of topic test	36	44	112	24	9	3.33
2	Use of standard examinations	72	58	80	15	0	3.83
3	Use of a variety of assessment strategies in physics instruction	7	24	54	124	16	2.48
4	Use of feedback from assessment to adjust teaching methods	4	12	63	142	4	2.42
5	Construction of assessment items for students	2	10	43	158	12	2.25
6	Use of peer assessment	1	6	21	144	53	1.92
7	Use of portfolio analysis	1	8	12	121	83	1.77
8	Use of feedback from assessment to adjust teaching resources	6	18	43	89	69	2.12
9	Use of project work as an assessment strategy	0	19	26	72	108	1.80
10	Performance of students in physics examinations	12	38	56	93	26	2.63
	Overall Mean						**2.46**

KEY:
VR – Very Frequently F – Frequently NS – Not Sure R – Rarely VI – Very Rarely MS – Mean Score (1.00 to 2.49 = Rarely Used, 2.50 – 3.50 = Not Sure while 3.51 - 5.00 = Frequently Used)

Table 38 shows that student teachers rarely used (*MS* = 2.46) the assessment strategies in secondary school physics instruction. It can be revealed further that the student teachers rarely used portfolio analysis (*MS* = 1.77), project work as an assessment strategy (*MS* = 1.80) and peer assessment (*MS* = 1.92). Furthermore, student teachers rarely used feedback from assessment to adjust teaching resources (*MS* = 2.12) and feedback from assessment to adjust teaching methods (*MS* = 2.42). However, the physics student teachers frequently used standard examinations (*MS* = 3.83) and end of topic tests (*MS* = 3.33). These findings implies that physics teacher education programmes may not have equipped the student teacher with adequate skills in the use of portfolio analysis, project work and on interpretation and use of feedback from assessment for effective secondary school physics instruction.

More data was collected from physics teacher trainers to establish the frequency of use of assessment strategies in physics teacher education programmes. The findings are summarised in Table 39.

Table 39: Frequency of Use of Assessment Strategies in Physics Teacher Education (Physics Teacher Trainers, n= 108)

NO	Item	VF *f*	F *f*	NS *f*	R *f*	VR *f*	*MS*
1	Assessment by observation	14	29	45	17	3	3.31
2	Questioning	78	23	6	1	0	4.65
3	Assess students as they work within groups	18	44	36	8	2	3.63
4	Use of laboratory reports in assessment	4	11	38	27	28	2.41
5	Students assessing their own work	2	8	12	62	24	2.09
6	Construction of assessment items	9	12	56	21	10	2.90
7	Adopt assessment items from previous examinations	63	39	3	3	0	4.50
8	Use of written tasks in assessing students	25	83	0	0	0	4.23
9	Balance of tasks in examinations to cover aspects of cognitive, affective and psychomotor skills	31	51	24	1	1	4.02
10	Use of assessment models to cater for students with learning disabilities	6	9	34	52	7	2.49
11	Use of IT skills in assessment	23	53	20	12	0	3.81

KEY:

VR – Very Frequently F – Frequently NS – Not Sure R – Rarely VI – Very Rarely MS – Mean Score (1.00 to 2.49 = Rarely Used, 2.50 – 3.50 = Not Sure while 3.51 - 5.00 = Frequently Used)

Table 39 indicates the frequently used assessment strategies in physics teacher education programmes are questioning (*MS* = 4.65), use of written tasks (*MS* = 4.23) that are largely adopted from previous examinations (*MS* = 4.50) and also, the tasks in the examinations are balanced to cover aspects of cognitive, affective and psychomotor skill (*MS* = 4.02). Other assessment strategies frequently used in physics teacher education programmes include group assessment (*MS* = 3.62) and the use of information technology in assessment (*MS* = 3.81). On the other hand, Students' self-assessment (*MS* = 2.09), use of laboratory reports in assessment (*MS* = 2.41) and the use of strategies to cater for students with learning disabilities (*MS* = 2.49) are the rarely used assessment strategies in physics teacher education programmes. The results call for the need to entrench the use of laboratory reports and strategies to cater for students with learning disabilities in physics teacher education programs for effective assessment in secondary school physics.

As it had been pointed out earlier, it is evident that the use of project work as an assessment strategy in both physics teacher education and secondary school physics instruction is rare. These findings are in agreement with the assertions that assessment policies and practices in Kenya are heavily norm referenced and summative (Jwan, 2016; Wanzala, 2016). Moreover, William (2004) notes that tests inhibit the development of formative assessment which is proven to raise achievement levels and reduce the gap between high and low achieving students. In addressing the need for curriculum innovation, Marcelo and Marina (2014) emphasised the need for teacher education to equip prospective teachers with effective assessment strategies that are congruent with instruction, that are continuous, collaborative and that use a wide range of tools and methods in the development of the subject matter. While Tofade, Elsner and Haines (2013) argues that best practices for assessment in physics are centred on employing questions to introduce students to central concepts and principles hence the need of student teachers to be equipped with questioning skills.

In physics instruction and particularly assessment, portfolios include a collection of student work samples that are assumed to reflect meaningful understanding of the underlying concept (Tofade, Elsner & Haines, 2013; Wartawan, 2017). In using portfolios in assessment of physics, a wide variety of products that may include tests, homework, laboratory reports and classroom presentations can be considered. Meng (2016) has further observed that portfolios provide an alternative assessment procedure to traditional examinations which usually provide a limited view of the knowledge a student has achieved. The use of portfolio analysis enables students to address problems grounded in real life context as tasks given are typically complex and require students to synthesise and apply problem solving approaches.

In contributing to the debate on the importance of portfolio analysis in physics, Amin (2013) has argued that tasks used in assessment of portfolios should be open-ended and should require students to use and apply knowledge in ways that demonstrate their understanding of the concept. It was further recommended by Amin that teachers should design checklists that indicate the essential steps to guide students in their portfolio building process. From the foregoing, it is important that physics teacher education programmes should consider incorporating techniques needed in building and using portfolios in daily instructional engagements.

4.5.3 Relevance of Assessment Strategies in Physics Teacher Education Programmes in Relation to Communication Skills of Student Teachers

Information was also collected from student teachers on the relevance of assessment strategies in physics teacher education in relation to their communication skills and findings summarised in Table 40.

Table 40: Relevance of Assessment Strategies in Physics Teacher Education Programmes to Acquisition of Communication Skills (Student Teachers, n= 351)

No	Assessment Strategies in Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Questioning	108	155	76	7	5	4.01
2	Assess students as they work in groups	77	45	130	65	34	3.19
3	Students assessing their own work	32	103	62	142	12	3.00
4	Use of written tasks in assessing students	123	144	49	24	11	3.98
5	Use of assessment strategies to cater for students with learning disabilities	98	122	102	23	6	3.80
	Overall Mean						**3.60**

KEY:

VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant
MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 - 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

Table 44 shows that assessment strategies in physics teacher education programmes are relevant (*MS* = 3.60) to acquisition of communication skills by the physics student teachers. Therefore, the assessment strategies are useful for acquisition of assessment skills in by student teachers. Document analysis of the KICD physics teaching syllabus and the KNEC syllabus revealed that little is mentioned on students assessing their own work, peer assessment, assessment of students as they work in groups and on assessment of students with learning disabilities. It was equally revealed that assessment in secondary school physics was entirely summative because emphasis was placed on use of written examinations. Further, scrutiny of the physics teacher education programmes revealed that modalities of peer assessment and group assessment are yet to be fully entrenched in physics teacher education.

The findings of the current research on little use of students' self-assessment and group assessment in secondary school physics instruction are similar to those of a study conducted by Sue and Michael (2014) in which a trial of peer assessment took place with second year students as part of their physics skills module and was followed by a group discussion. The study done by Sue and Michael involved students looking at each other's work such as presentations, assignments, group work and assessing it against pre- agreed criteria. It was found that when averaged, students were accurate in their marking with just a slight tendency to over mark by 0.11 out of 17. It was thus concluded that when guided, students can give valid marks in peer assessment. Similarly, in a study conducted by Marsh (2007), it was revealed that peer assessment enhances students' meta-cognition, helps students make judgement about their own learning and provides them with information for setting goals and self-monitoring. Findings of the current research therefore reveal the need for utilising peer assessment and students' self-assessment in both physics teacher education and in secondary school physics instruction.

Whereas questioning is a frequent part of science talk, it is essential in learning of physics since it involves both the teacher and the learner (Harlen, 2010). While Black and Harrison (2004) identified that teacher questioning can be used to collect evidence about students' understanding of what they know, what they can do, what they do not know and what they partly know. Similarly, Chin (2007) identifies questioning as key to active and meaningful learning and that it facilitates scientific enquiry. Chin (2007) further supports Harlen's stance that questions should come from both the teacher and the students. In the current research, it was revealed that questioning is one of the relevant strategies in physics teacher education classrooms and therefore, physics teacher education programmes should endeavour to equip student teachers with techniques of effective questioning.

Findings of the current study on emphasis on use of written tasks in assessment are also similar to those of a longitudinal research that followed a cohort of students for eight years in England (Pollard et al., 2009) in which it was also established that assessment by teachers in the classrooms was largely summative. Further, teachers were increasingly focused on performance outcomes rather than learning processes of students and those students also had adopted summative criteria in commenting on their own work. As Williams (2001) has observed, summative assessment promotes shallow and superficial learning rather than deep conceptual understanding. Williams further argues that test performance can become more highly valued than what is being learned and methods of assessment may only be restricted to what is necessary for passing tests.

In encouraging the use of alternative assessment to testing, Boggs (2009) compared the assessment practices of student teachers from Mississippi at Tennessee in which he established that 83.2% of teachers from Mississippi spent class time preparing students for standard tests as they were determinants for certification and placement, while 54.8% of teachers from Tennessee used class time to prepare for tests which are not solely used for certification. The situation in Mississippi is partly similar to that in Kenya on the large extent of use of standard tests in both physics teacher education and in secondary school physics instruction. The use of standard tests tends to align physics instruction to the attainment of desired grades in examination at the expense of other assessment strategies that can build the students' skills, knowledge and attitude in physics. Moreover, interaction between the teacher and students in the classroom allows the teacher to gather information about the students through observation, questioning, listening to informal discussions and through reviewing of written tasks whether on boards or in students' notebooks. Pollard, Triggs, Broadfoot, McNess and Osborne (2008) have observed that information gathered from students may be stored and used to plan future learning opportunities. On the other hand, William (2001) and the American Association of Physics Teachers (2016) have indicated that the information gathered may be inconclusive or even contradictory and therefore more useful in formative assessment.

In outlining successful assessment strategies for use with students with learning disabilities in physics classrooms, the West Lothian Council Educational Psychology Service (2017) advocated for applying of wait time before calling on a student to respond. This method allows students who process information slowly to understand what the teacher asked and to think of the response. Moreover, teachers should be able to use multisensory approach to assessment where more than one sense is used at a time as it assists students who are struggling readers or who have a challenge in writing. Similarly, physics teachers can model in problem solving by using graphic organizers, use of the Universal Design for Learning

(UDL) and through assessment strategies that allow students to learn in a more flexible way. Assessment strategies in physics teacher education programmes should therefore incorporate assessment strategies that can cater for students with learning disabilities so as to improve communication in secondary school physics instruction.

4.5.4 Relevance of Assessment Strategies in Physics Teacher Education Programmes in Relation to Skills in use of Resource Materials by Student Teachers

Information on the relevance of assessment strategies in physics teacher education programmes in relation to skills in use of resource materials by student teachers was established and presented in Table 41.

Table 41: Relevance of Assessment Strategies in Physics Teacher Education to Acquisition of Skills in use of Resource Materials (Student Teachers, n= 351)

No	Assessment Strategies in Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Use of laboratory reports to assess students in physics instruction	126	154	23	46	2	4.01
2	Use of laboratory reports to assess students in physics examination	112	109	98	31	1	3.85
3	Use of project work in assessment	93	119	78	52	9	3.67
4	Use of portfolio analysis	72	116	133	23	7	3.64
	Overall Mean						**3.79**

KEY:
VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant
MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 - 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

Table 41 indicates that assessment strategies in physics teacher education programmes are relevant (*MS* = 3.79) to acquisition of skills in use of resources. Further, a critical look at the

Kenya Institute of Curriculum Development Physics teaching syllabus led to the realisation that little is mentioned on how laboratory reports and project work should be utilised in physics assessment. Noticeable were a few class projects mentioned at the end of some topics with no guidelines of how they were to be developed or even assessed. Moreover, little is captured on the use of portfolio analysis in assessment of the students. This lack of guidance on use of laboratory reports, project work and portfolio analysis in physics assessment is more likely to hinder their use in secondary school physics instruction, and yet these assessment strategies are often resource intensive (Vingsle, 2014)

Moreover, the American Association of Physics Teachers (AAPT, 2016) has retaliated that physics laboratories should be used for engagement in significant experiences with experimental processes that include designing investigations. Laboratory work should develop a broad array of basic skills and tools of experimental physics and data analysis and the success in achieving laboratory goals is demonstrated by communicating results. The AAPT further argued that students should develop expertise in clear and cogent reporting of experimental design, observations, analysis and conclusion in a variety of formats such as informal group discussions, oral presentations, use of laboratory papers and laboratory reports. Moreover, Zhicheng and Barry-Stock (2003) observed that assessment as a feedback mechanism should be entrenched at all levels of experimentation to enhance learning of knowledge, skills and processes in physics. When assessment of practical work is improved, learning of physics is also improved.

In a research conducted by Olzan (2016) that sought to assess the impact of project work in physics instruction conducted by pre- service teachers at Kaye Academic College of Education in Israel, it was established that project work was able to promote meaningful learning, higher motivation and active involvement of students in learning during the entire course. Project work also improved student attitudes towards learning physics, reduced fear and increased student self-efficacy and enjoyment of learning. When used in assessment, project work was seen as minimizing the fear associated with written examinations besides increasing the contact of students with resource materials. In weighing in on the need to use project work in assessment of physics, the Kenya Institute of Education (2005) noted that project work offers varied experience to learners and that its use enriches experimentation and enhances the creativity of students.

Aina (2013) has observed that incompetency of physics teachers in the area of effective utilization of resources in assessment has been blamed on insufficient awareness on the types of resources for use in evaluating different content areas. While poor academic achievement in physics has been attributed to poor assessment strategies by teachers and ineffective utilization of resources in physics instruction (Olzan, 2016) and therefore, any improvement in performance of students in secondary school physics emanates from use of appropriate assessment strategies and associated resources that revolve around the use of laboratory reports, project work and portfolio analysis.

On modalities of assessing students' project work, Melinda (2017) urges for creation of rubrics that outline the criteria of various components of the students' work that should be assessed for a more accurate and useful feedback. The rubrics further provide clear expectations for a project and examine the products as well as the entire project building process. This is alongside explaining what constitutes excellence in the project work and ways of minimizing bias and subjectivity in its assessment. Physics student teachers should therefore have an understanding of the instructional resources available to them, how to effectively utilize the available resources in project development, have an understanding of the need to involve their students in planning and executing of project work, and also, on the development of rubrics and understanding of the entire process of assessment of project work.

4.5.5 Relevance of Assessment Strategies in Physics Teacher Education Programmes in Relation to Skills in use of Information Technology by Student Teachers

Data was collected from physics student teachers on the relevance of assessment strategies in physics teacher education programmes in relation to skills in use of information technology, and findings shown in Table 42.

Table 42: Relevance of Assessment Strategies in Physics Teacher Education to Acquisition of Skills in use of Information Technology (Student Teachers, n= 351)

No	Assessment Strategies in Physics Teacher Education	VR *f*	R *f*	NS *f*	I *f*	VI *f*	*MS*
1	Use of information technology in assessment of physics	72	116	133	23	7	3.64
2	Use of computer software in assessment of physics	88	136	99	27	1	3.81
3	Use of web technologies in assessment of physics	102	100	106	33	10	3.72
	Mean Score						**3.72**

KEY:
VR – Very Relevant R – Relevant NS – Not Sure I – Irrelevant VI – Very Irrelevant
MS – Mean Score (1.00 to 2.49 = Irrelevant, 2.50 - 3.50 = Not Sure while 3.51 to 5.00 = Relevant)

As shown in Table 42, assessment strategies in physics teacher education programmes are relevant (*MS* = 3.72) to acquisition of skills in use of information technology by the student teachers. The assessment strategies should be there utilised in training programmes of student teachers. More data on the use of information technology in assessment of secondary school physics by the student teachers was gathered from the secondary school head teachers and summarised in Table 43.

Table 43: Use of Information Technology in Assessment of Secondary School Physics (Secondary School Head Teachers, n =225)

No	Item	V. G *f*	Good *f*	NS *f*	Poor *f*	V. P *f*	*MS*
1	Use of IT in assessment of physics	25	42	44	81	33	2.75
2	Use of computer software in physics assessment	9	12	38	109	57	2.14
3	Use of web technology in assessment of physics	6	11	83	104	21	2.45
	Overall Mean						**2.45**

KEY:
MS – Mean Score (1.00 to 2.49 = Poor, 2.50 to 3.50 = Average while 3.51 to 5.00 = Good)

Table 43 indicates that student teachers were poor (*MS* = 2.45) with use of information technology in assessment of secondary school physics, indicating that the student teachers are poorly prepared for use of information technology in assessment of secondary school physics. The results of the current study are similar to that of a study conducted by Zahra and Ali (2004) in which effects on use of information technology on teaching and learning of physics courses in Iran was determined.

The study by Zahra and Ali further sought to establish whether physics students who were taught and assessed using computer system, internet facilities and projectors performed better than those who went through traditional instruction. Findings indicated that information technology had a significant impact on instruction and assessment of physics and it was recommended that only qualified and competent physics teachers with skills in use of information technology in physics instruction should be deployed to high schools. Zahra and Ali further noted that physics teachers should be trained on how to teach and conduct assessment of learners using a variety of computer applications such as competent based laboratories, multimedia simulations and intelligent tutors. From the findings of the current research alongside the findings by Zahra and Ali (2004), it is important that use of information technology and applications of computer programmes in assessment is focussed on both secondary school physics instruction and physics teacher education programmes.

The current research further endeavoured to establish assessment strategies that should be emphasised in physics teacher education programmes for acquisition of pedagogic skills, and responses from the questionnaire of physics student teachers and heads of physics subject were represented in Table 44.

Table 44: Assessment Strategies that should be Emphasised in Physics teacher Education Programmes (Student Teachers, n= 351; Heads of Physics Subject, n= 225)

No	Assessment Strategies	Student Teachers *f*	Heads of physics subjects *f*	Total *f* (%)
1	Question and answer	198	122	320 (55.5)
2	Project work	187	131	318(55.2)
3	Laboratory reports	177	101	278(48.3)
4	Portfolio analysis	182	92	274(47.6)
5	Use of IT in assessment of physics	163	101	264(45.8)
6	Assessment of group work	121	132	253(43.9)
7	Use of end of topic questions	109	122	231(40.1)
8	Peer assessment	117	91	208(36.1)
9	Use of standard examinations	131	77	208(36.1)
10	Student self-assessment	93	37	130(22.6)

Table 44 revealed that the following assessment strategies should be emphasised in physics teacher education programmes; question and answer method (55.5%), use of project work in assessment (55.2%), use of laboratory reports in assessment (48.3%), portfolio analysis (47.6%) and use of information technology in assessment of physics (45.8%). It was also noted that assessment strategies that cater for the varied needs of students in secondary school physics classrooms should be emphasised in the training programmes of teachers. One of the remarks made by the heads of physics subject in in light of improvements that should be made on assessment strategies in physics teacher education programmes for acquisition of pedagogic skills by student teachers was as follows:

> HoS 129: "*There are many students who need special assistance. Some are slow learners, some are orphaned while others are sick. Physics teacher should be sensitive while assessing them"*

The excerpt point to the need for student teachers to use assessment strategies that address a variety of needs of students in physics classrooms, which include learning ability and social aspects of the students. Hoffman et al. (2001) has asserted that the use of question and answer approach in assessment enables teachers to discover what students know and can do, and further strategies for effective use of questioning that the physics student teacher should utilize.

Moreover, to enhance classroom communication, there is need to allow reasonable waiting time when using question and answer approach in order to provide students with sufficient opportunity to think after the question before they are called upon to respond. Teachers should also be able to use a variety of approaches that cover open-ended questions, questions that require more than a right or wrong answer and also, teachers should be able to refer to Bloom's taxonomy when developing the questions in order to promote higher order thinking. As Dixon and Haigh (2009) have further argued, one way to practise skills on assessment is to invite students to participate and engage in the phases of formative assessment by allowing students to contribute questions, ideas and thoughts and also listen to peers and discuss ideas.

In outlining the assessment strategies that support learning of physics, the Science, Technology and Mathematics in Early Education and Development Centre (2010) argued that one of the key elements in support of teacher learning is the use of performance based assignments where teachers plan, implement, document and analyse investigations related to content that they just learnt in the previous sessions. In a similar study by Zhicheng and Judith (2003) that investigated teachers' assessment practices across teaching levels and content areas, it was revealed that teachers were not well prepared to meet the demands of classroom assessment due to inadequate training. Earlier, Stiggins and Conklin (1992) had lamented that, as much as teachers are primarily responsible for evaluating instruction and student learning, with the common consensus that teachers use a variety of assessment techniques, teachers may be inadequately trained in certain areas of classroom assessment. Frameworks for training physics teachers should therefore entrench assessment procedures to enable teachers model the same in secondary school physics instruction.

Moreover, web platforms offer opportunities for stakeholders to contribute to the education of students and it is an effective way of conveying information between students and teachers and amongst students (Mishra & Koehler 2007). Student can access assessment tasks and guidelines through the web and communication to parents on academic achievement of the learners can easily be conveyed to the parents. And as Bryan (2017) has noted, web-technologies can also offer opportunities for teachers to evaluate their lessons and improve on subsequent lessons because teachers can access opinions of experts that can be used to restructure classroom activities. Physics teacher education programmes should therefore equip student teachers with the required knowledge and skills in the use of a variety of assessment strategies more so, in the integration of information technology in physics assessment.

Whenever project work is used in physics instruction, it challenges students to think beyond the boundaries of the classroom and also enables students to question, evaluate and extrapolate their ideas. Use of project work as an assessment strategy therefore requires teachers who are knowledgeable on the project building process. The teachers also require to be well versed with levels of developing the project. Further, skills in assessment of project work are necessary in order to go beyond a letter grade and assess skills associated with project work such as creativity, collaboration, problem solving abilities of students and innovation. And as revealed by the current study, project work should be emphasised in physics teacher education programmes for acquisition of pedagogic skills necessary in secondary school physics instruction.

It is also necessary that physics teacher education programmes equally focus on use of assessment strategies that cater for students with learning disabilities in order to facilitate learning of students with varied abilities and needs in physics instruction. Neerusha and Anilaa (2014) have identified the need to allow extra time particularly when an assignment involves significant demands and writing skills. Moreover, there is need to provide supplementary assignment such as recorded interviews or handmade models as some of the strategies in universal design for inclusive learning in science classroom. From the discussions in the current study, it is necessary that assessment of students with learning disabilities is practised effectively in physics teacher education programmes and in secondary school physics.

In announcing the changes in policy on reforms in assessment in England of 2005, the school minister said that the entire nation was putting its faith in teachers and that England was much closer to having the best possible basis for rigorous assessment of students than their competitor countries. The teachers were given greater responsibility for assessment in which information on performance of students was gathered routinely. This led to focus on improving the ability of the teachers to conduct the required assessment of the learners. Teacher education was tasked with equipping the teachers with the required knowledge and skills to facilitate meaningful and valid assessment of their students with little bias. Just like in England, standards on the use of assessment strategies in training of teachers should be set in Kenya in order to enable student teachers and physics teachers at large to take a greater control of assessment of their students' learning. This may include the use of assessment strategies that should be emphasised in physics teacher education programmes for acquisition of pedagogic skills by the student teacher as established by the current research.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary and conclusions of the findings of this research basing on the research questions, the theoretical framework that guided the study and the discussions made in Chapter Four. The chapter also makes recommendations for future researches that are informed by the findings and limitations of the current study. The following research questions that guided the study have been answered through the discussion:

1. What is the relevance of objectives of physics teacher education programmes in relation to pedagogic skills of student teachers?
2. What is the relevance of content in physics teacher education programmes in relation to pedagogic skills of student teachers?
3. To what extent are methods of teaching in physics teacher education programmes relevant in relation to pedagogic skills of student teachers?
4. To what extent are assessment strategies in physics teacher education programmes relevant in relation to pedagogic skills of student teachers?

5.2 Summary of the Findings

The findings of the study were therefore summarised as below:

5.2.1 Relevance of Objectives of Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

To establish the degree to which an instructional program objectives are achieved in reference to Tylers'(1949) model, objective of physics teacher education programmes were relevant to acquisition of subject matter knowledge (*MS* = 4.27) of the student teachers, to acquisition of assessment skills (*MS* = 3.37), to acquisition of communications skills (*MS* = 4.34), to acquisition of skills in use of resource material (*MS* = 4.14) and to acquisition of skills in use of information technology (*MS* = 3.78) by the physics student teachers. Physics student teachers were good (*MS* = 3.74) in their engagement with objectives of secondary school physics, average (*MS* = 3.22) in their engagement with objectives on use of resource material in secondary school physics instructions, and poor (*MS* = 2.27) in their engagement with objectives on use of information technology in secondary school physics instruction.

Moreover, suggestions for improvement on the objectives on subject matter knowledge included the need to address the key content areas in secondary school physics and need to address each level of expertise covered adequately. The training programmes are also to focus on developing adequate knowledge and skills in subject matter necessary for effective secondary school physics instruction. Further, in order to enable physics student teachers acquire the requisite assessment skills in secondary school physics instruction, it was revealed that objectives of physics teacher education programmes need to entrench formative assessment procedures and techniques at all levels of delivery of physics content and further, emphasise on the use of question and answer method. Similarly, objectives of physics teacher education programmes needs to aim at developing skills in construction of assessment items to enable student teachers conduct effective summative assessment in secondary school physics.

It was further established that existing gaps in the objectives of physics teacher education programs should be addressed through placing emphasis on 21st century skills such as problem solving abilities, critical thinking skills and global awareness. Other areas of knowledge and skills desired of the physics student teachers to be addressed by the objectives of physics teacher education programmes were found to be: Knowledge of children's rights, learner safety, ability to work as a team, collaboration skills and guidance and counselling skills. Furthermore, physics student teachers need to be of high moral standing, honest and of high integrity. It is therefore necessary that objectives of physics teacher education programmes address such concerns in order to improve the communication skills of secondary school physics teachers.

To enhance the acquisition of skills in use of resource materials by the student teachers, it was revealed that manipulation of laboratory apparatus, construction of scientific devices, designing and selection of appropriate media resources alongside improvisation should be emphasised in the objectives of physics teacher education programmes. More importantly, it was established that objectives of physics teacher education programmes should outline the relationship between technology, pedagogy and content and the objectives to endeavour to present technology as a means to delivering physics content. In view of the foregoing, it was established that the objectives should outline how to plan and deliver instruction within technological settings as a way of enhancing skills of student teachers in the use of information technology in secondary school physics.

5.2.2 Relevance of Content in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

The degree to which content in physics teacher training programmes address the content in secondary school physics as argued by Tyler (1949) was determined and findings summarised as follows: Content in physics teacher education programmes is relevant to acquisition of subject matter knowledge (*MS* = 3.32) of the physics student teachers. It is also, relevant to acquisition of assessment skills (*MS* = 4.17), acquisition of communication skills (*MS* = 4.20), to acquisition of skills in use of resource material (*MS* = 4.17), while student teachers were not sure of the relevance of content in physics teacher education to acquisition of skills in use of information technology (*MS* = 2.83).

Student teachers were found to be average (*MS* = 3.03) in their engagement with physics content in secondary school physics and it was further revealed that the student teachers were average in their engagement with aspects of assessment (*MS* = 2.74) in secondary school physics instruction, average in exhibiting their communication skills (*MS* = 2.56), average in uses of resource material (*MS* = 3.08) while poor with the use of information technology (*MS* = 2.39) in secondary school physics instruction.

In giving an appraisal to the training institution, it was revealed that the salient areas that content in physics teacher education programmes need to address include, strengthening of the existing weak link between content covered during training and the content in secondary school physics that the student teachers are expected to deliver during their teaching practice. This is more so in experimental work and in the use of information technology. Further, for the student teachers to acquire substantive assessment skills in secondary school physics instruction, it is found that formative assessment processes and strategies needs to be entrenched at all levels of content delivery in physics teacher education programmes. The current research also revealed that content in physics teacher education programmes needs be tailored on improving communication skills required for effective instruction in secondary school physics classrooms. This is because the classrooms comprise of learners drawn from diverse cultural settings and of varied needs and abilities. Content in physics teacher education programmes was also found to enable student teachers acquire skills for good classroom control and management. More so, in the existing setups where secondary school physics students have varied cognitive abilities, psychological, social, physical and economic needs.

It was equally established that content in physics teacher education programmes needs to cover approaches of effective use of resource material in physics instruction, and also focus on improvisation as a means of enhancing the manipulative skills of the student teachers. The study further revealed that information technology needs to be taught in physics teacher education programmes as a means of acquiring physics content, rather than in contexts that the latter is an addition to physics content courses and to pedagogy courses. It was also revealed that content in physics teacher education programmes to be such that it integrates information technology courses in teaching of physics content in the training of teachers. These include the use of manipulative technological material, projected material and non-projected technological material.

5.2.3 Relevance of Methods of Teaching in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

Interactive lecture, experimentation, use of laboratory reports, project work, student demonstration and teacher demonstration were found to be relevant to the acquisition of subject matter knowledge (*MS* = 3.80) of the physics student teachers. Similarly, it was established that the above listed methods of teaching were also relevant to acquisition of assessment skills (*MS* = 3.51) of the physics student teachers. Moreover, for acquisition of communication skills, interactive lecture (*MS* =4.16), group work (*MS* = 4.23) and peer teaching (*MS* = 3.97) were found to be relevant while student teachers were not sure of the use of models to cater for students with learning disabilities (*MS* = 3.32) and the use of student demonstration (*MS* = 3.05) to their acquisition of communication skills. On the other hand, lecture method (*MS* = 2.43) was regarded as irrelevant to acquisition of communication skills by the physics student teachers.

For acquisition of skills in use of resource materials, interactive lecture, teacher demonstration, student demonstration, group work, peer teaching and the use of models that cater for students with learning disabilities were found to be relevant (*MS* = 3.44) while experimentation, project work, use of information technology in teaching and assessment of physics were found to be relevant to acquisition of skills in use of information technology (*MS* = 4.14) by the student teachers.

In matching of methods of teaching used in physics teacher education with methods used by student teachers in secondary school physics instruction as advocated by Tyler (1949), it was revealed that the most frequently used methods of teaching in training of physics teachers were lecture method (*MS* = 4.60), use of research reports (*MS* = 4.52), group work (*MS* = 4.43) and interactive lecture method (*MS* = 4.22). On the other hand, the use of strategies that cater for students with learning disabilities (*MS* = 2.06), student demonstration (*MS* = 2.090 and peer teaching (*MS* = 2.34) were rarely used in the training process of the physics student teachers. It was equally established that student teachers frequently used lecture method (*MS* = 3.99), question and answer approach (*MS* = 3.92), experimentation (*MS* = 3.82), teacher demonstration (*MS* = 3.72) and interactive lecture method (*MS* = 3.52) in secondary school physics instruction. At the same time, student teachers rarely used teaching strategies that cater for students with learning disabilities (*MS* = 1.97), laboratory reports (*MS* = 2.00), project work (*MS* = 2.13) and students demonstrations (*MS* = 2.47) during their teaching practice. Student teachers were also found to be good in use of physics models (*MS* = 3.92) and in utilisation of laboratory facilities (*MS* = 3.72) but poor in improvisation (*MS* = 2.39) and in use of resources to cater for students with learning disabilities (*MS* = 2.03)

Heads of physics subject in secondary schools where the student teachers undertook their teaching practice were not sure of the use of computer software (*MS* = 2.79) by student teachers in physics instruction and also on the extent to which the student teachers used information technology in assessing secondary school physics students (*MS* = 2.52). It was found that student teachers rarely used projected slides (*MS* = 1.69), computer simulations (*MS* = 1.94) and in general, student teachers rarely used information technology (*MS* = 2.48) in secondary school physics instruction.

Moreover, it was also established that improvements on methods of teaching in physics teacher education programmes for acquisition of pedagogic skills include the need to enhance student-centred approaches to instruction, practice formative assessment technique in order for student teachers to apply similar processes in secondary school physics instruction and integrate information technology in lesson presentation and subsequent delivery of physics content. It was also established that there is need for student teachers to be equipped with skills that can enable them conduct meaningful instruction in classrooms where there are delinquent students and also to meet the learning needs of students with learning disabilities in secondary school physics classrooms. Moreover, methods of teaching that should be emphasised in physics teacher education programmes for acquisition of pedagogic skills were found to be interactive lecture (62.5%), experimentation (58.2%), use of information technology in teaching (57.3%), project work (51.0%) and the use of strategies that cater for students with learning disabilities (40.8%).

5.2.4 Relevance of Assessment Strategies in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

Assessment strategies in physics teacher education programmes were found to be relevant to acquisition of subject matter knowledge (*MS* = 3.80), to acquisition of assessment skills (*MS* = 3.85), to acquisition of communication skills (*MS* = 3.60), to acquisition of skills in use of resource material (*MS* = 3.79) and to the acquisition of skills in use of information technology (*MS* = 3.72).

It was also established that the frequently used assessment strategies in physics teacher education programmes include; questioning (*MS* = 4.65), use of written tasks (*MS* = 4.23) that are largely adopted from previous examinations (*MS* = 4.50), the use of group work (*MS* = 3.65) and the use of information technology in assessment (*MS* = 3.81). On the other hand, students self-assessment (*MS* = 2.09), use of laboratory reports in assessment (*MS* = 2.41) and the use of assessment strategies that cater for students with learning disabilities (*MS* = 2.49) were rarely used in physics teacher education. Student teachers were found to be good at the use of standard examinations (*MS* = 3.83) and in the use of end of topic tests (*MS* = 3.33) while they were poor in use of portfolio analysis (*MS* = 1.77), in the use of project work as an assessment strategy (*MS* = 1.80), in peer assessment (*MS* = 1.92), in use of feedback from assessment to adjust teaching resources (*MS* =2.12) and in use of feedback from assessment to adjust teaching methods (*MS* = 2.42).

To match the training with actual outcome in secondary school physics instruction as conducted by the student teachers (Tyler, 1949), it was also revealed that student teachers were average in the use of information technology in assessment of physics (*MS* = 2.75) while they were poor in use of computer software in physics assessment (*MS* = 2.14) and in use of web technology in assessment of physics (*MS* = 2.45). Further, improvement on assessment strategies used in physics teacher education programmes for acquisition of skills in use of resource materials by the student teachers were identified as the need to enhance the use of laboratory reports in assessment (*MS* = 4.01), enhance the use of project work in assessment (*MS* = 3.67) and the need to use portfolio analysis (*MS* = 3.64) in the training of physics teachers.

Further, in an attempt to give an appraisal to the training institutions as advance by Tyler, assessment strategies that should be emphasised in physics teacher education programmes for acquisition of pedagogic skills were established as the use of question and answer approach (55.5%), Project work (55.2%), use of laboratory reports in assessment (48.35%), portfolio analysis (47.6%) and the use of information technology in assessment (45.8%).

5.3 Conclusions

Conclusions based on the findings of the study were made in order to find answers to the research questions as follows:

The study sought to answer the following research questions:

5.3.1 What is the Relevance of Objectives of Physics Teacher Education Programmes in Relation to Pedagogic skills of student teachers?

Objectives of physics teacher education programmes as currently constituted are relevant in relation to pedagogic skills of student teachers. However the objectives are inadequate in addressing the required content in secondary school physics, integration of project work in teaching, assessment of physics and incorporating applications of physics knowledge. The objectives need to be tailored on the need to produce teachers who can pursue further training in physics and education and also, objectives of physics teacher education need to align training to assessment frameworks in secondary school physics, target enhancing formative assessment, use of laboratory reports in assessment, use of portfolio analysis, address professionalism, inculcate skills in management of students with varied needs, target equipping trainees with 21^{st} century skills, focus on management of resource materials and integration of information technology at all levels of content delivery and assessment of physics.

5.3.2 What is the Relevance of Content in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers?

Content in physics teacher education programmes is relevant in relation to pedagogic skills of physics student teachers. However, the study established that the content needs to be enhanced to address key areas in secondary school physics, employ a variety of teaching and assessment strategies with a focus on use of project work and information technology, development of assessment items and rubrics, approaches to effective classroom control and management of students with varied needs, aspects of communication and collaboration in school set ups, focus on global awareness, financial literacy, civil literacy, health literacy, children's rights and safety measures, alongside improvisation in physics classrooms.

5.3.3 To What Extent are Methods of Teaching in Physics Teacher Education Programmes Relevant in Relation to Pedagogic Skills of Student Teachers?

Methods of teaching in physics teacher education programmes are relevant in relation to pedagogic skills of student teachers and the methods of teaching that should be emphasised in physics teacher education programmes include Interactive lecture, experimentation, use of information technology in teaching, use of project work and use of teaching strategies that cater for students with learning disabilities.

5.3.4 To What Extent are Assessment Strategies in Physics Teacher Education Programmes Relevant in Relation to Pedagogic Skills of Student Teachers?

Assessment strategies in physics teacher education programmes are relevant in relation to pedagogic skills of student teachers. Further, the assessment strategies that should be emphasised in physics teacher education programmes for acquisition of pedagogic skills include: the use of question and answer method, use of project work in assessment, use of laboratory reports in assessment, portfolio analysis and use of information technology in assessment of physics.

5.4 Recommendations

5.4.1 Objectives that are Relevant in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

Based on the literature reviewed, theoretical framework on which the current study was anchored, findings and discussions of the current research, The following recommendations have been made under objectives, content, methods of teaching and assessment strategies that should comprise physics teacher education programmes.

5.4.1.1 Objectives Relevant to Acquisition of Subject Matter Knowledge

For acquisition of subject matter knowledge by the physics student teachers, objectives of physics teacher education programmes as offered by public universities should focus on the following:

1. Emphasis to be placed on content that is relevant to trainees' future work as secondary school physics teachers
2. Optional courses in physics to be offered to allow specialisation
3. Need to integrate project work in development of physics knowledge
4. Address applications of physics knowledge and emerging issues in physics

5. Seek to produce physics teachers who can participate in development of physics knowledge and contribute towards research in physics.

5.4.1.2 Objectives Relevant to Acquisition of Assessment Skills

Similarly, objectives of physics teacher education programmes in public universities should seek to address the following in relation to acquisition of assessment skills by the student teachers.

1 Objectives of physics teacher education programmes should align the training programmes to specific assessment frameworks.

2 Seek to prepare teachers for assessment in secondary school physics with emphasis of the use of project work, laboratory reports and on the use of portfolio analysis.

3 Objectives should focus on formative assessment strategies in physics instruction.

4 Allow the use of a variety of assessment techniques in physics teacher education.

5 Focus on development of assessment items and rubrics necessary in assessment of secondary school physics.

5.4.1.3 Objectives Relevant to Acquisition of Communication Skills

For acquisition of communication skills by the student teachers, objectives of physics teacher education programmes should address the following:

1 Focus on developing trainees' understanding of the complexity of teaching physics.

2 To instil professionalism and develop the trainees' ability to work in a collaborative environment.

3 Instil skills and attitude necessary to manage learners from varied religious, social, economic and cultural backgrounds, and meet instructional needs of students with varied learning abilities and those with learning disabilities.
4 Inculcate 21st century skills and processes necessary for effective management of secondary school physics curriculum and physics instruction.
5 Focus on developing teachers who are of high moral standing, high integrity and those with good problem solving abilities.

5.4.1.4 Objectives Relevant to Acquisition of Skills in Use of Resource Materials

Further, for acquisition of skills in use of resource materials by physics student teachers, objectives of physics teacher education programmes should:

1 Align programmes to use of resource materials in delivery of physics content.
2 Aim to enhance knowledge and skills in designing and use of resource materials especially apparatus and equipment to facilitate content delivery at all levels of secondary school physics syllabus
3 Seek to equip trainees with knowledge necessary for effective management of resources in physics instruction.
4 Inculcate skills in construction of scientific devices and also in improvisation of common laboratory apparatus.
5 Emphasise the use of interactive lecture approach, experimentation, project work and use of models that cater for students with learning disabilities.

5.4.1.5 Objectives Relevant to Acquisition of Skills in use of Information Technology

Objectives of physics teacher education programmes should also endeavour to address the following area for acquisition of skills in use of information technology by the student teachers.

1 Align the training programmes to use of information technology in delivery of subject matter knowledge with emphasis on the use of computer software, simulations, projected content and web technologies.

2 Training should enable teachers integrate information technology at all levels of content delivery in secondary school physics instruction.

3 Focus on preparing teachers to use information technology effectively in assessment of secondary school physics.

5.4.2 Content that is Relevant in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

Based on the literature reviewed, theoretical framework on which the current study was anchored and findings of the current research, the following recommendations are outlined on the content that should comprise physics teacher education programmes for acquisition of pedagogic skills by student teachers.

5.4.2.1 Content Relevant for Acquisition of Subject Matter Knowledge

For acquisition of subject matter knowledge, content in physics teacher education programmes should include the following:

1. Key content areas in secondary school physics that include; Mechanics, Electricity and Magnetism, Optics, Thermal Physics, Dynamics, Oscillations and Waves , Solid State Physics, Quantum Mechanics, Classical Mechanics and Statistical Mechanics.

2. Include project work in physics both in training and on school placement programmes.
3. Include optional courses to allow for specialisation and future training.
4. Address applications and emerging issues in each of the content areas.

5.4.2.2 Content Relevant for Acquisition of Assessment Skills

For acquisition of assessment skills by the physics student teachers, content in physics teacher education programmes in General Methods of Teaching, Tests and Measurements, Special Methods of Teaching Physics, teaching practice and project work while on Teaching Practice should comprise the following:

1. Development of assessment items for secondary school instruction.
2. Integrate formative assessment procedures in delivery of physics content.
3. Use of project work in assessment of physics
4. Development of rubrics, use of portfolio analysis and laboratory reports in physics instruction

5.4.2.3 Content Relevant for Acquisition of Communication Skills

Similarly , for acquisition of communication skills by the student teachers, content in Communication Skills I and II, Quantitative skills, State Society and Development, Entrepreneurship, HIV and AIDS Instruction, Research Methodology, General Methods of Teaching, Introduction to Psychology, Human Growth and Development, Human Behaviour, Guidance and Counselling, Philosophy of Education, History of Education, Sociology and Comparative Education, Introduction to Logic and Critical Thinking, Problem Solving and Institutional Operation, Environmental Education, Educational Administration and

Institutional Management, Planning and Economics of Education, Special Needs Education and Teaching Practice should address the following:

1. Secondary school physics curriculum
2. Classroom control, classroom organisation, children's rights and learner safety.
3. Classroom behaviour management and management of delinquent students, those with health problems and issues of drug abuse
4. Philosophy and policy in education
5. Global awareness, civil literacy, financial literacy, environmental awareness and health awareness.
6. Critical thinking, problem solving and conflict resolution in secondary school environment.
7. Effective communication in secondary school physics
8. Team work and collaboration in school setups
9. Management of students with learning disabilities
10. Civil obligations and integrity issues

5.4.2.4 Content Relevant for Acquisition of Skills in Use of Resource Material

Courses in physics teacher education programmes that include; Educational Media and Resources, Educational Technology, Instructional Technology and Media Practicals, Teaching Practice and Project work on Teaching Practice should address the following areas for acquisition of skills in use of resource materials by the student teachers**.**

1. Emphasis to be placed on selecting, designing and use of resource material in secondary school physics instruction.
2. Use project work to address specific content areas in secondary school physics.

3. Focus on improvisation in secondary school physics instruction.
4. Address selection and use of resource materials to cater for students with learning disabilities.

5.4.2.5 Content Relevant for Acquisition of Skills in use of Information Technology

For content in physics teacher education programmes to enable student teachers acquire skills in use of information technology, courses that include Introduction to Computers, Introduction to use of Spread sheets and Databases, Internet Computing, Information Technology and Society and Internet Control and Security issues should endeavour to address the following:

1 Use information technology as a pedagogical tool in delivery of physics content.

2 Use of software, projected slides, simulations and web technology in physics instruction.

3. Use of software and web technology in assessment of physics.

5.4.3 Methods of Teaching that are Relevant in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

In any teaching episode, there are numerous methods that can be employed depending on the nature of subject matter, availability of resource materials and the learners. The current research has revealed the methods of teaching that should be emphasised in physics teacher education programmes for acquisition of pedagogic skills as:

1. Interactive lecture method
2. Experimentation
3. Use of information technology in teaching
4. Project work
5. Use of teaching strategies that cater for students with learning disabilities

Moreover, for acquisition of each of the pedagogic skills, methods of teaching that should be emphasised for acquisition as revealed by the current research are recommended as follows:

5.4.3.1 Methods of Teaching Relevant for Acquisition of Subject Matter knowledge

1. Interactive lecture
2. Experimentation
3. Project work
4. Use of Laboratory Reports

5.4.3.2 Methods of teaching Relevant for Acquisition of Assessment Skills

1. Interactive Lecture
2. Experimentation
3. Laboratory Reports
4. Project Work

5.4.3.3 Methods of Teaching Relevant for Acquisition of Communication Skills

1 Interactive Lecture

2 Group work

3 Peer teaching

4 Use of teaching strategies that caters for students with learning disabilities

5.4.3.4 Methods of Teaching Relevant for Acquisition of Skills in use of Resource Materials

1. Interactive lecture
2. Teacher demonstration
3. Group work
4. Use of teaching strategies that cater for students with learning disabilities
5. Peer teaching

5.4.3.5 Methods of Teaching Relevant for Acquisition of Skills in use of Information Technology

1 Experimentation

2 Project work

3 Use of computer software in teaching of physics

4 Use of projected slides

5 Use of computer simulations

5.4.4 Assessment Strategies that are Relevant in Physics Teacher Education Programmes in Relation to Pedagogic Skills of Student Teachers

From the findings of the current research, the following are recommended as methods of teaching that should be emphasised in physics teacher education programmes for acquisition of pedagogic skills by the student teachers.

1. Question and answer approach
2. Project work
3. Use of laboratory reports
4. Portfolio analysis
5. Use of information technology in assessment

Further, in light of each of the pedagogic skills needed for effective secondary school physics instruction, the following recommendations are made.

5.4.4.1 Assessment Strategies Relevant to Acquisition of Subject Matter Knowledge

1. Question and answer approach
2. Use of laboratory reports
3. Use of project work
4. Portfolio analysis

5.4.4.2 Assessment Strategies Relevant to Acquisition of Assessment Skills

1. Question and answer approach
2. Assessment by observation
3. Use of written tasks in assessment
4. Assessment of group work
5. Portfolio analysis

5.4.4.3 Assessment Strategies Relevant to Acquisition of Communication Skills

1. Question and answer approach
2. Use of written tasks in assessment
3. Use of assessment strategies that cater for students with learning disabilities
4. Assessment of group work

5.4.4.4 Assessment Strategies Relevant to Acquisition of Skills in Use of Resource Materials

1. Use of laboratory reports
2. Project work
3. Portfolio analysis

5.4.4.5 Assessment Strategies Relevant to Acquisition of Skills in use of Information Technology

1. Use of information technology in assessment
2. Use of computer software in assessment
3. Use of web technologies in assessment

5.5 Theoretical and Pedagogical Implications

The current research attempted to contribute to theory of classroom instruction by by focussing on pedagogic skills of physics student teachers. The study established the existing gaps and improvements that should be made on the objectives, content, methods of teaching and assessment strategies in physics teacher education programmes in relation to pedagogic skills requisite for effective secondary school physics instruction. The findings of this research will therefore enable:

1. Public universities in Kenya to enhance their physics teacher education programmes for acquisition of pedagogic skills by the student teachers.
2. Curriculum developers to entrench methods of teaching and assessment strategies that should be emphasised in physics teacher education programmes in secondary school physics curriculum.
3. Policy makers to consider the use of assessment strategies identified in this study in secondary school physics in order to improve on learning outcomes.
4. Teachers' in-service programme developers to initiate mitigation measures on instructional deficiencies that are as a result of training gaps identified in physics teacher education programmes.

5.6 Suggestions for Further Research

Based on the limitations and findings of the current research, the following suggestions are made for further research

1. The current study employed the use of structured questionnaires and document analysis as means of collecting data on objectives of physics teacher education programmes and secondary school physics instruction. For more robust evidence,

future research may follow up with the use of lesson observations and face-to- face interviews with the respondents.

2. The current research was a descriptive survey that focused on evaluation of content in physics teacher education programmes for acquisition of pedagogic skills. There is need for another study to establish the relationship between training programmes of physics teachers and learners' achievement in secondary school physics in light of physics majors, minors and equal units.
3. The current research sought to establish the relevance of methods of teaching in physics teacher education programmes in relation to pedagogic skills of student teachers. Future research can focus on the impact of methods of teaching used in secondary school physics instruction to students' enrolment in physics.
4. In the current study, relevance of assessment strategies in physics teacher education programmes was determined. A follow up study on the factors the influence the choice of assessment strategies used in physics instruction is necessary.

REFERENCES

Aberson, C. L. (2010). Applied Power Analysis for the Behavioral Science. ISBN 1- 8487-2

Adenivan, M. A. (2006). Strategies and Utilization of Improvised Instructional Materials and Students Achievement and Attitude in Ekiti Secondary School. *Nigeria International Journal of Research in Education, 3(2):* 91 – 96.

Adeyemi, K. J. (2016). Influence of communication on teachers job performance. Retrieved May 1, 2017 from www.academia.edu/6789084/Influence_Communication_on_Teachers_Job

Aina, J. K. (2013). Instructional Materials and Improvisation in Physics Class: Implications for Teaching and Learning. *Journal of Research and Methods in Education. 2 (5):* 38 – 42.

Alkharusi, H. (2009). Correlates of Teacher Education and Students' Academic Performance in an Educational Measurement Course. *International Journal of Learning. 1(4)*: 217-232.

Amadala, M., Ocholla, A. & Memba, E. (2012). Effect of Practical work in Physics on Girls' Performance, Attitude Change and Skills Acquisition in Form Two – Three Secondary School' Transition in Kenya. *International Journal of Humanities and Social Sciences, 2 (23)*: 151- 166.

Amanda, O. & Mathew, H. (2014). Teaching the way they were Taught? Revisiting the Sources of Teaching Knowledge and the Role of Prior Experience in Shaping Faculty Teaching Practices. *Journal of Higher Education, 68*(1): 29-45.

American Association of Physics Teachers (2017). The 2017 Annual Report. Retrieved December 2, 2017 from https://www.aapt.org/aboutaapt/upload/2017-Annual-Report.pdf

American Physical Society (2013). The Physics Teacher. Retrieved August 10, 2014 from scitation.aip.org/content/aapt/journal/ajp.

Amimo, C.(2003). Tailoring Higher Education in Kenya to the Demands of Post- Industrial work place. *Baraton Interdisciplinary Research Journal, 2(10)*: 52 – 58.

Amin, M. T. (2013). Portfolio-based Physics Learning Models to Improve Critical Thinking Skills. *International Journal of Education and Research, 1(9)*: 12- 17.

Amunga, J. K., Musasia, M.A. & Musera, G. (2011). Disparities in the Physics Achievement and Enrolment in Secondary Schools in Western Province: Implications for Strategy and Renewal, Problems of Education in the 21st Century. *Journal of Social Sciences, 31 (31)*: 18- 32.

Anais Brasileiros Dermatologia (2014). Presenting data in tables and charts. Retrieved February 14, 2017, from http://www.ncbi.nlm.nih.gov/pmc/articles/pmc4008059

Angeli, C. & Valanides, N. (2009). Epistemological and Methodological Issues for Conceptualization, Development and Assessment of ICT-TPACK: Advances in Technological Pedagogical Content Knowledge (TPACK). *Computer Education, 2(1):* 154 – 168.

Anouk, B., Bart, C. & Nyaga, M. (2006). Integrating ICT in Teacher Training: Reflections, Practice and Policy Implications – A case study of the learning resource centre at the Kenya Technical Teachers College.

Antriman, V.O. (2010). The Condition of Secondary School Education in the Philippines: Recent Developments and Challenges for Substantive Improvements. *The Australian Educational Research, 34(1)*: 33 – 54.

Anwaruddin, S. (2015). ICT in Language and Literacy Education in Bangladesh: A critical review. *Journal of Current Issues in Education, 18(1)*: 1 – 12.

Appleton, K. (2003). How do Beginning Primary School Teachers cope with Science? Towards an Understanding of Science Teaching Practice. *Research in Science Education, 33(1):* 1 – 15.

Apuke, O. D. (2017). Quantitative Research Methods : A Synopsis Approach. Retrieved September 4, 2017 from https://www.researchgate.net/publication/320346875_Quantitative_Research

Assessment Reform Group (2002). Assessment for Learning: Research based Principles to guide classroom practice. Retrieved February 3, 2016 from www.hkeaa.edu.hk/DocLibrary/SBA/HKDSE/Eng_DVD/doc/Afl_principles.pdf

Association of American Publishers (2016). Quality Content for Learning Resources. Retrieved March 4, 2018 from http://www.edb.gov.hk/334.

Auseon, J. (1995). The Role of Pedagogical and Subject Matter Knowledge in Preservice Art Teaching. *Marilyn Zurmuelin Education, 13(4*): 24 – 68.

Ayeni, A. J. (2010). Teachers instructional task performance and principals' Supervisory roles as correlates of quality assurance in secondary schools in Ondo state. Unpublished doctoral dissertation, Obafemi Awolowo University, Ife-Ife, Nigeria.

Ball, D. L. & McDiarmid, G. W. (2017). The Subject Matter Preparation of Teachers. Retrieved November 24, 2017 from https://www.educ.msu.edu/NCRTL/PDTs/NCRTL/IssuePapers/ip894.pdf

Barrack, M. O. (2014). Factors Contributing to Low Enrolment of Students in Physics at Secondary School Level in Central Division, Garrisa District, Kenya. Kenyatta University: Unpublished M.ed Thesis.

Barron, B. & Darling-Hammoud, L. (2008). *Teaching for meaningful Learning: A review of research on inquiry-based and cooperative learning: what we know about teaching for understanding.* San Francisco, CA: Jossey-Bass

Bee, B. (2012). Reflections of Pre-service Teachers on Classroom Communication Strengths and Weaknesses. *Humanising Language Teaching, 1(14)*: 28 - 39

Besty, L.N. (2012). The Application of Community Service Learning in Science Education. *Asia-Pacific Forum on Science Learning and Teaching, 13*(2): 1-15.

Black, C. & Harrison, B. (2004). *Assessment for Learning – Putting it into Practice*. Berkshire: Open University Press.

Bloom, B. S (1956). *Taxonomy of Educational Objectives, Handbook 1: The Cognitive Domain*. New York, NY: David Mckay Co. Inc.

Boggs, A. (2009). Alternative Assessment in the Secondary Physics Classroom. Research Paper submitted to graduate school of Ball state University, Indiana.

Boyd, D., Grossman, P., Lankford, H., Loeb, S. & Wyckoff, J. (2009). Teacher Preparation and Student Achievement. *Educational Evaluation and Policy Analysis, 31(1):* 416 – 439.

Boyo, A. (2010). *Identifying Problems associated with Studying Physics in Lagos State, Nigeria*. Lagos: Ministry of Science and Technology.

Bransford, J., Brown, A. & Cocking, R. (Eds.). (2000). *How People Learn: Brain, Mind, Experience and School*. Washington: National Academy Press.

Brekelmans, M., Brok, P., Tartwick, J. & Wubbels, T. (2005). An Interpersonal Perspective on Teacher Behaviour in the Classroom. In L. V. Barnes (Ed.), *Contemporary Teaching and Teacher Issues* (pp. 197-226). New York: Nova Science Publishers

Brekke, M. & Hogstad, P. (2010). New Teaching Method - using Computer Technology in Physics, Mathematics and Computer Sciences. *Journal of Digital Society, 1*(1): 34-41.

Bryan, J. (2017). Technology for Physics Instruction. *Journal of Contemporary Issues in Technology and Teacher Education,, 6(2): 149* – 161.

Bryan, J. (2005). Video Analysis: Real-World Explorations for Secondary School Learning. *Journal of Learning with Technology, 32*(6): 22-24.

Buckingham, B. & Nicholas, R. (2013). Effective Teaching Preparation and Student Achievement: High Correlation. Retrieval August 26th, 2014 from

bomalone@bbns.org.
Buckingham, D. (2007). Digital Media Literacies. Rethinking Media Education in the Age of the Internet. *Research in Comparative and International Education, 2 (1)*: 43 – 55.
Bullock, V. P., LaBella, T., Clingan, Z., Ding, G. & Thibado, P. M. (2006). Enhancing the Student-Instructor Interaction Frequency. *Journal of Physics Teaching, 3(40)*: 535 - 541.

Cains, R.A. & Brown, C.R. (2006). Newly Qualified Teachers: A Comparative Analysis of the Perceptions held by B.Ed and PGCE Trained Primary Teachers of their Training Routes. *Educational Psychology, 16(2):* 257 – 270.

Caron, R. (2010). Le journal de Quebec; Les (normaux) Penalises. Retrieved February 15, 2018 from https//lejournaldequebec/archives/2010/10/2010/019-20935.html

Caruso, J. B. & Kvarik, R. B. (2005). Students and Information Technology: convenience, connection, control and learning. Retrieved May 5, 2016 from https://library.educause.edu/resources/2005/10/ecar-study-of-students-and-Information-Technology

Cassandra, P. (2014). The Real Time Instructor: Observing Tool for Future Teachers. Paper Presented at a Workshop for Interactive Science Classrooms at San Jose State University. May 20th.

CBC News (2010). Quebec to review special needs education. Retrieved March 10, 2018 from http://www.cbc.calcanada/montreal/story/2010/04/20/quebec.special-needs-_students

Cheng, E. (2013). Nurturing the instructional design and teaching. Retrieved February 16, 2018 from https://www.tandfonline.com/doilabs/10.1080/1359866x.2013.869546

Chin, C. (2007). Teacher questioning in science classrooms: Approaches that stimulate productive thinking. Retrieved May 16, 2016 from https://onlinelibrary.wiley.com/doi/abs/10.1002/tea.2017

Colburn, A. (2008). Making Inquiry Successful. *The science teacher*, *(7)*: 12-21.

CEMASTEA (2013). A comparative study on supervision and practice of ASEI-PDSI approach in secondary schools in Kenya. Unpublished lesson observation report.

Cohen, L. & Manion, L. (2006). *Research Methods in Education*. London: Croom-Helm Limited.

Collins, A., Brown, J. & Newman, S. (1989). Cognitive Apprenticeship: Teaching the Crafts of writing and Mathematics in L. Renic (Ed), *Knowing, Learning and Instruction: Essays in honour of Robert Glaser*. Hillsdale, NJ: Erlbaum.

Commission of University Education (2014). Standards and Guidelines. Retrieved March 8, 2017 from www.cue.or.ke/index.php/downloads-1/category/16-standards-and-guidelines

Conant, J. (1963). *The Education of American Teachers*. New York: McGraw-Hill.

Craig, B. (2010). Portfolios in Science Education. Paper presented to the centre for teaching excellence, United States military academy West Point, NY. June 6th .

Creswell, J. W. & Plano, C. V. (2011). Designing and Conducting Mixed Methods Research (2nd ed.). Thousand Oaks, CA: SAGE Publications.

Cronbach, L. (1986). Tyler;s Contribution to Measurement and Evaluation. Retrieved May 2, 2015 from http://www.jstor.org/stable/42589138

Damian, B., Russell, M. & Laura, C. (2004). Measuring Teacher' Technology Use: why Multiple Measures are more Revealing. *Journal of Research on Technology Education*, *37(1)*: 45 – 64.

Darling-Hammoud, L. (2008). Introduction: Teaching and Learning for Understanding. In L. Darling Hammoud et al. (Eds.*), Powerful Learning: what we know about Teaching for Understanding*. San Francisco, CA: Jossey-Bass.

DeMonte, J. (2013). *High Quality Professional Development for Teachers, Supporting Teacher Training to Improve Student Learning*. Washington DC: Center for American Progress.

Dolores, G. (2011). The how of 21st century teaching. Retrieved January 27th, 2017 from http://pnetwork.com/2011/03/08/21st-century-science-teaching-getting-students-beyc

Dufresne, R. J.(2004). Assessing-to-learn: Formative assessment in physics instruction. Retrieved January 20th, 2017 from http://kolt.ku.edu.tr/wp-content/uploads/sites/18/2016/06/dufresne-2004alf.pdf

Dixon, H. & Haigh, M. (2009). Changing Mathematics Teachers' Conceptions of Assessment and Feedback. *Teacher Development, 13(2)*: 173 – 186.

Egerton University (2014). Students' Handbook. Egerton University.

Etkina, E. (2015). Pedagogical Content Knowledge and Preparation of High School Teachers. *Journal of Physics Education Research, 6 (6)*: 20-27.

Etkina, E., Murthy, S. & Zon, X. (2006). Using Introductory Laboratories to Engage Students in Experimental Design. *Journal of Physics, 7 (79)*: 200 - 213.

Etkina, E. & Van-Heuvelen, V. (2007). Scientific Abilities and their Assessment. *Journal of Education and Research, 2(2): 20 – 43.*

Europe-Africa Quality Connect (2012). Guidelines for Universities. Retrieved March 8, 2017 from www.unam.edu.na/sites/default/files/europe-africaqualityconnectevaluationguidelinesforuniversities

Filkins, J. W. & Ferrari, J. R. (2003). The DePau Values Project and the Devi: Assessing Students' Perceptions of a private University's Core Mission and Values. *Journal of collage and Character, 2(1)*: 1 – 39.

Flick, L. & Bell, R. (2000). Preparing Tomorrows Science Teachers to use Technology. Guidelines for Science Educators. *Contemporary Issues in Technology and Teacher Education, 1*(1): 39-60.

Frankel, J. R. & Wallen, N.E. (2006). *How to Design and Evaluate Research in Education*. New York: McGraw-Hill.

Freedman, R. A. (2012). *Challenges in Teaching and Learning Introductory Physics*. Unpublished report of the department of Physics. California: University of California.

Freeman, D. (2006). *A Framework for Teacher Learning and Development*. *Centre for Teacher Education, Training and Research*. Vermont USA : Brattleboro.

Gall, M. D., Borg, W. R. & Gall, J. P. (2007). *Educational Research an Introduction*. London: Longman.

Gardner, J. (2011). *Ethical Guidelines for Educational Research*. London: British Educational Research Association.

George Lucas Educational Foundation (2015). Inquiry-based learning in science classrooms. Retrieved September 24, 2016 from http://www.edutopia.org/practice/inquiry-based-learning-science-classroom

Gillao, R. & Little, E. (2003). Classroom Behavior Problem: The Relationship between Preparedness, Classroom Experiences and Self Efficacy in Graduates and Teachers. *Australian Journal of Educational & Developmental Psychology, 10(3):* 21 – 34.

Gibbs, G. & Coffey, M. (2004). *The Impact of Training and University Teachers on their Teaching Skills and their Approach to Learning of Students*. London: Sage Publication.

Goe, L. (2007). The Link between Teacher Quality and Student Outcomes: A Research Synthesis: Washington DC: national Comprehensive Center for Teacher Quality. Retrieved August 22, 2014 from http://www.tq.source.org/link.ph

Government of Kenya (2007). *Kenya Vision 2013*. Nairobi: Government printers.

Government of Kenya (2012). Sessional Paper No. 14. Nairobi: Government Press.

Grumbine, R. & Alden, B. (2006). Teaching Science to Students with Learning Disabilities. Journal of Science Teacher, 73(3): 26 – 31.

Halim, L. & Meerah, S. M. (2002). Science Trainees. Teachers Pedagogical Content Knowledge and its Influence on Physics Teaching. *Research in Science and Technological Education. 20(2):* 215 – 225.

Harlen, W. (2010). Purposes and Procedures for assessing science process skills. *Assessment in Education Principles, Policy and Practice*, 6 (1): 129 – 144.

Harley, K. & Simiyu, F. (2012). *Teacher Education in Sub-Saharan Africa.* Unpublished Formative Evaluation report.

Harris, A. & Jones, M. (2017). Leading professional learning: putting teachers at the centre. Retrieved September 30, 2017 from https:///www.tandfonline.com/doi/full/10.1080/13632434.2017.1343705

Heritage, M. (2007). Formative assessment: What do teachers need to know and do? Retrieved May 22, 2017 from https://journals.sagepub.com/doi/10.1177/003172170708900210

Higgins, M. R. (2008). 21st Century learning skills: Global learning in an urban middle school. Retrieved February 6, 2016 from https://www.researchgate.net/.../21st+CENTURY+LEARNING+SKILLS_GLOBAL+LEARNING

Hilburn, R. & Ruth, H. (2003). Why many undergraduate physics programmes are good, but few are great. *Journal of Physics Today, 56(2)*: 42-52.

Hinton-Bayre, A. (2010). Holding out for a reliability change from confusion to solution: a comment on maasses, “The standard error in the Jacobson and Truax Reliability change index. *Journal for international Neuropsychol, 3(10)*: 894 – 898.

Huaying, B. (2012). Development of Teacher Training in China. Paper presented at the National Forum of Teacher Education, Cotonou. May 20th.

Hult, H. (2012). Teacher Training and the Educational System in Poland. Some Notes. Report presented at the department of Education and Psychology. Linkoping University.

Ifeakor, A.C. (2005). Enhancing Professional STM Teachers' Role in Lifelong Education: Strategies and Needs for Teachers Performance. 46th Annual Conference Proceedings of STAN, 129-133

Igwe, I. O. (2003). *Principles of Science and Science Teaching*. Enugu: Jones Communication Publishers.

Ilker, E.,Suleiman, A. M. & Rukayya, S. A. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics, 5(1)*: 1 – 4.

Institute of Physics (2017). Resources for Early Career Teachers. Retrieved May 20, 2018 from www.iop.org/education/itp/resources/index.html.

Inter University Council of East Africa (2014). Report on External Peer Review of the Bachelor of Education Programmes Offered at Maseno University.IUCEA

Isaac, B., Lindsey, C. & David, W. (2016). Physics Teachers' Views on their Initial Teacher Education. *Australian Journal of Teacher Education, 41*(7): 36-55.

Jan, E., Geraldine, C., Rebecca, L. & Joost , L. (2017). Student – Centerd and Teacher – Centered Learning Environments: What Students Think. *Journal of Teaching in Higher Education, 12(2):* 246 – 266.

Jansen, O., Lasher, N., Lugo, L., Colman, S. & Sica-Fosella, S. (2015). Science Portfolio Handbook. Retrieved August 14, 2012, from http://www.orange.k12.nj.us/cms/lib/NJO/000601/cetricity/Domains/28/science Portfolio Handbook version 3.3 pdf

Jarosievitz, B. (2017). Physics Teaching Activities and Resources used Innovatively In Higher Education. *In Informatica 38(3)*: 22 – 26. ISSN: 1419 – 2527.

Jing-Jing, H. (2014). A Critical Review of Pedagogical Content Knowledge Components: Nature, Principle and Trend. *International Journal of Education and Research, 2(4)*: 411 – 425.

Johnson, R. D. (2016). How does a qualitative researcher remain objective and unbiased. Retrieved November 4, 2016 from https://www.researchgate.net/post/How_does_a_qualitative_researcherremainobjectiveandunbiased

Johnson, R. D., Johnson, R. T. & Smith, K. A. (2013). Cooperative Learning: Improving University Instruction by Basing Practice on Validated Theory. *Journal of Excellence in University Teaching, 2 (5)*: 1 – 26.

Jones, I. & Alcock, L. (2014). Peer Assessment within Assessment Criteria. *Studies in Higher Education, 39(10)*: 1774 – 1787.

Kaiser, K. (2009). Protecting respondents' confidentiality in qualitative research. Retrieve May 2, 2015 from https:www.ncbi.nlm.nih,gov/pmc/articles/PMC2805454

Kalei, A. (2016). University Graduates Employability Skills and the Labour Market Demands in Kenya. International Journal of Business and Management Science, 2(10): 1 – 8.

Kamisah, O., Lilia, H. & Subahan, M. (2006). What Malaysian Science Teachers Need to Improve in their Science Instruction: A Comparison Across Gender, School Location and area of Specialisation. *Eurasian Journal of Mathematics, Science and Technology Education, 2 (2):* 58-76.

Karen, K. (2009). Protecting Respondents Confidentiality in Qualitative Research. Retrieved June 9, 2016 from http://www.ncbi.nlm.nih.gov/pmc/article/PMC2805454/

Kasomo, D. (2007). Research Methods Made Simple for University Students. Retrieved August 14, 2012, from http://www.infibeam.com/Books/researh- methods-made-

Kenya Institute of Education (2003). *Secondary School Physics Syllabus*. Nairobi: Kenya Institute of Education.

Kenya Institute of Education (2005). Secondary Syllabus Volume II, Nairobi: KIE.

Kenya National Examinations Council (2013) .The Year 2012 KCSE Candidates Performance Report. Nairobi.

Kenya National Examinations Council (2009). The Year 2008 KCSE Candidates Performance Report. Nairobi.

Kenya National Examinations Council (2007). The Year 2006 KCSE Candidates Performance Report. Nairobi.

Kenya National Examinations Council (2004). The Year 2003 KCSE Candidates Performance Report. Nairobi.

Kenyatta University (2014). The University Calendar. Kenyatta University.

Kind, V. (2009). Pedagogical Content Knowledge in Science Education: Potential and Perspectives for Progress. *Studies in Science Education, 45(2)*: 169 – 204.

Kinyanjui, K. (2007). The transformation of higher education in Kenya: challenges and opportunities. Paper presented at the mjadala on social policy, Governance and Development in Kenya on 9th July, Nairobi, Safari club.

Kira, E. & Nchunga, A. (2016). Improvisation in Teaching Physics Concepts: Teachers' Experiences and Perceptions. *International Journal of Research Studies in Educational Technology,* 5(1): 49 – 61.

Kola, A. J. (2017). Uses of Instructional Materials for Teaching and Learning Physics in Edu and Patigi Local Government Areas, Nigeria. *International Journal of Research in Education, 4*(2): 74-79.

Kothari, C. R. (2004). Research Methodology. Methods and Techniques. New Delhi: Wishwa Prakashan.

Krathwohl, D. R. (2006). *Educational and Social Science Research an Integrated Approach*. Toronto: Longman.

Kriek, J. and Grayson, D. (2009). A Holistic Professional Development Model for South African Physical Science Teachers. *South Africa Journal of Education, 29(2)*: 185 – 203.

Kulas, J. (2008). SPSS Essentials: Managing and Analyzing Social Science Data. Jossey-Bass

Kurt, H., Gungor, F. & Ekici, G. (2014). The Relationship Among Teacher Efficacy, Efficacy Regarding Teaching, and Responsibility for Students Achievement. Procedia-Social and Behavoural Sciences, 116(2014): 802 – 807.

Laurillard, D. (2009). The Pedagogical Challenges to Collaborative Technologies. *Journal of Computer – Supported Collaborative Learning, 4(1):* 5 -12.

Lavrakas, P. J. (2008). Survey Research Methods. Sage Publications. ISBN 978 – 1-41291 – 808 - 4

Levine, A. (2006). Educating School Teachers, Washington, D.C: The Education Schools Project. Retrieved August 22, 2014 from http://www.edschools.org/pdf/educatingteachers_report.pdf

Levy, S., Elylon, B. & Scherz, Z. (2006). Teaching Communication Skills in Science: Tracing Teacher Change. The department of Science and Teaching, The Weizmann Institute of Science, Rachort, Israel.

Libbi, F. (2009). Curriculum Evaluation. Retrieved January 8, 2015, from urriculumevaluationog.blogspot.com/2009/07/Ralph_tyler_curriculum_design .html

Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic Inquiry*. Newbury Park, CA: Sage Publishers.

Llado, A. P. (2014). Students Perceptions of Peer Assessment: An Interdisciplinary

Study. *Assessment and Evaluation in Higher Education, 39(5*): 592 -610.

Maseno University (2013). *Report on Self-Assessment.* Maseno: Maseno University.

Marcelo, A. B. & Marina, V. B. (2014). Teaching and Learning Physics: Integrating Research into Practice. Proceedings of the GIREP-MPTL International Conference held in Palermo Italy. July 7th.

Mash, C. J. (2007). A critical analysis of the use of formative assessment in school. *Educational Research and Policy Practice, 6(2)*: 25 – 29.

Mason, M. (2010). "Sample size and saturation in PhD studies using qualitative interviews", In Forum Qualitative sozialforschang/Forum: Qualitative Social Research, article 8.

Mayes, T. & Fowler, C. (2006). Learners, learning literacy and pedagogy of e-learning in Martin, A. And Madigan, D. (eds.). Digital Literacies for Learning. *Journal of innovation in Teaching and Learning in Information and Computer Science, 6(1):* 7 - 12.

McCaffrey, D. F., Lockwood, J. R., Koretz, D. M. and Hamilton, L. S. (2003). *Evaluating Value-added Models for Teacher Accountability*: New York: RAND Corporation.

McCawley, P. (2009). *Methods of Conducting an Educational Needs Assessment*. University of Idaho Extension. University of Idaho.

Meng, K. L. (2016). The Use of Academic Portfolio in the Learning and Assessment of Physics Students from a Singapore Private College. *International Journal of Assessment Tools in Education. 3(2):* 151 – 160.

Mertler, C.A. & Campbell, C. (2005). Measuring teachers' knowledge and application of classroom assessment concept, development of the assessment literacyinventory in Canada; Annual meeting of the American Educational Research Association.

Metiri Group (2006). Technology in Schools: what research says. Commissioned by cisco systems. Retrieved December 20, 2016 from http://www.cisco.com/web/strategy/docs/education/TechnologyinSchoolsReport.pdf

Metiri Group & NCREL (2003). EnGauge 21ST Century Skills: Literacy in the Digital Age. Chicago, IL: NCREL.

McFarlane, A. (2003). Assessment for the Digital Age. *Assessment in Education, Principles, policy and Practice, 10 (3)*: 261 – 266.

Mcwilliam, E., Poronik, P. & Taylor, P. (2008). Redesigning Science Pedagogy: Reversing the Flight from Science. *Journal of Science Education and Technology, 1(7)*: 17- 26.

Miller, T. L. (2012). Constructivism and the Nature of Science. Retrieved August 2, 2017 from http;www.springerlink.com/content/ur/28ho1608032674/fulltext.pdf

Ministry of Education (2016). National Education Sector Plan. Volume One: Basic Education Programmesme-Rationale and Approach. Retrieved June 2, 2017 from www.education.go.ke/index.php/downloads/category/17-policy-documents?

Mishra, P. & Koehler, M. (2007). Technological Pedagogical Content Knowledge (TPCK): Confronting the wicked problems of teaching with technology. In R. Carlsen, K. McFerrin, J. Price, R. Weber, & D. Willis (Eds), Proceedings of Society Information Technology & Teacher Education International Conference 2007. Pp 2214 – 2226. Chesapeake, VA: AACE.

Mottanya, C. (2013). *Curriculum Implications of Employers' Rating and Perceptions of Employability of University Graduates*. Paper presented at the African Universities General Conference at Libreville Gabon. May 6th.

Moi University (2014). The University Calendar. Moi University.

Montebon, D. R. (2015). Student Teaching Enhancement Programmes (STEP) and Pre-service Teachers' Teaching Efficacy in Science. *Journal of Computer and Education Research, 3(5)*: 1 – 17.

Muindi, B. (2013). Kenyan Employers Prefer Private University Graduates. Daily Nation, Sunday June 9.

Munishi, O., Nuni, E., Okumu, O., Mutai, P., Mwangasha, G., Omolo, H. & Munyeke, F. (2006). *Secondary Physics Form 1*. Nairobi: Kenya Literature Bureau.

Murei, G. (2016). Impact of Low Enrolment in Secondary School Physics to Attainment of Kenya Vision 2030: A Case Study of Nandi North Sub-County. *Journal of Educational Research, 7(3):* 88 – 94.

Muriithi, E.M and Kyalo, P. (2018). Influence of Teacher Characteristic in use of Project Method in Teaching Physics in Kenyan Secondary Schools. *International Journal of Innovative Research and development. 7(3):* 120-134.

Musasia, A. M., Ocholla, A. A. & Sakwa, T, W. (2016). Physics Practical Work and its Influence on Students Academic Achievement. *Journal of Education and Practice, 7 (28):*129- 134.

Neerusha, B. & Anilla, A. (2014). Using Universal Design for Learning to Construct Inclusive Science Classrooms for Diverse Learners. *Learning Landscapes, 7 (2)*:59 – 80.

Neff, S. L. & Nebel, M. L. (2004). Professional development needs assessment descriptive summary. Retrieved June 5, 2016 from Jan.ucc.nau.edu/Isn/research/papers/FUSD_AIMS_TEST.pdf

Ng'ang'a, K. G. (2018). Factors influencing low enrolment in physics amoung secondary school students in Murang'a South district, Kenya. Retrieved June 4, 2019 From karuspace.karu.ac.ke/handle/20.500.12092/1753

Nguyen, N.,Williams, J. & Nguyen, T. (2012). The Use of ICT in Teaching Tertiary Physics: Technology and Pedagogy. *Asia-Pacific Forum on Science Learning and Teaching, 13*(2): 1 - 6.

Niess, M. L. (2005). Preparing Teachers to Teach Science and Mathematics with Technology. *Journal of Teaching and Teacher Education, 21(2*): 509 – 523.

Nivalainen, V., Asikainen, M. A. & Hirvonen, P. E. (2013). Pre-service Teachers' Objectives and their Experience of Practical Work. *Journal of Physics Education and Research, 9 (12)*: 1-17.

Nkpa, N. (1997). *Educational Research for modern scholars.* Lagos. Fourth Dimension Publishers.

Nui, N. W. & Wahome, A. N. (2006). SMASSE project. *Tsukuba Journal of Educational Study, 3 (25*): 47-56.

Nurshamshida, S. Nabilah, A. & Nurlatifar, Y. (2013). Strategies of Teaching Science using Inquiry Based Science Technology. *Journal of Procedural-Science and Behavioral Sciences, 1(90)*: 582-592.

Nyongesa, W. E. (2014). Factors influencing students' enrolment in physics in secondary schools: A case of Bungoma East sub-county, Kenya. Retrieved June 2, 2017 from http://ir.mu.ac.ke.8080/xmlui/handle/123456789/74

Ofsted, R. (2008). *Success in Science*. London: Office for Standards in Education.

Ogbe, A. & Omenka, J. (2017). Improvisation and Utilization of Resources in the Teaching and Learning of Science and Mathematics in Secondary Schools in Cross Rivers State. *Global Journal of Educational Research. 16 (2)*: 21 – 28.

Okeke, S. O. & Okeye, N. E. (2013). Effective Resource Utilization. A better Approach to Teaching and Learning of Physics. *Physics journal of Interdisciplinary Studies, 2(6)*: 35 – 39.

Okere, M. I. (2000). Status of Physics Teaching and Examining in Secondary Schools. *Journal of Humanities and Social Sciences and Education, 3(2):* 132 – 145.

Okwelle, P. C. (2014). *Enhancing Teachers Competence in the use of Practical Instructional Materials in Physics in Senior Secondary Schools*. Paper presented at the teachers; development workshop on enhancing teachers competence in the use of practical instructional materials in senior secondary schools at Akabuka River State Nigeria. July 30.

Oladimeji, A. B. (2015). Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. Retieved May 10, 2016 from www.npmj.org/article.asp?issn=1117-1936;year=2015;volume=22;issue

Olagunju, A. M. & Abiona, O. F. (2008). Production and Utilization of resources in Biology Education. A Case Study of South West Nigeria Secondary Schools. *International Journal of African and American Studies, 7(2)*: 49 – 56.

O`Leary, C. (2008). Teachers as Instructional Designers. *The journal of the lrish Science Teachers Association, 44(1)*: 39-67.

O'Leary, Z. (2014). *The Essential Guide to doing your Research Project*. (2nd ed.) Thousand Oaks, CA: SAGE Publications.

Oleson, A. & Hora, M. T. (2012). Teaching the way they were taught? Revisting the sources of teaching knowledge and the role of prio experience in shaping faculty teaching practices. Retrieved August 10, 2014, from http://www.wcer.wibc.edu/publications/workingPapers/papers.php

Olympiou, G. & Zacharia, Z. (2011). Blending physical and virtual manipulatives: An effort to improve students' conceptual understanding through science laboratory experimentation. Retrieved March 2, 2016 from https://onlinelibrary.wiley.com/doi/full/10.1002/sce.20463

Olzan, O. (2016). A project-based learning approach to teaching physics for pre-service teacher education. Retrieved April 22, 2017 from http://dx. do/org/10.1080/2331186X.2016.1200833

Omuseno, E.O. (2009). Views of Physics Teachers on the need to Train and Retain Physics Teachers in Nigeria, *Africa Research Review, 3(1):*314-325.

Onasanya, A., Adegbija, M., Olumorin, C. and Daramola, F. (2008). Education Reforms and Assessment of Teachers Compitence in Instructional Media Technology use in Junior Secondary Schools in Kwara State. In: *Education Reform in Nigeria – Past, Present and Future*. Lawal, A.R (Eds). Stirling- Horden Publishers, ltd. Lagos

Oriahi, C. I., Uhumuavi, P.O. & Aguele, L. I. (2012). Choice of Science and Technology Subjects among Secondary School Students. *Journal of Social Sciences, 22 (3)*: 191- 198.

Otero, V., Johnson, A. & Goldberg, F. (1999). How does Computers Facilitate the Development of Physics Knowledge by Prospective Elementary Teachers? *Journal of Education, 181(2)*: 57-89.

Owour, O. E. (2015). Experimental Approach as Methodology in Teaching Physics in Secondary Schools. *International Journal of Academic Research in Business and Social Science, 5(6):* 385-406.

Paige, J. (2009). The 21st Century Skills Movement. *Educational Leadership, 9(67*): 1 -26.

Pacific Policy Research Centre (2010). 21st Century Skills for Students and Teachers. Retrieved February 3, 2016 from www.ksbe.edu/_assets/spi/pdf/21_century_skills_full.pdf

Perry, J.N. (2009). What is Simulation. Retrieved March 20,2018 from http://olc.spsd,sk.cs/DE/PD/INSTR/SIMUL/index.html.

Peters, R. S. (1977). *Education and Education of Teachers*. London: Routledge and Kegan Paul.

Physics Teacher Education (2017). Improving the Education of Future Physics Teachers. Retrieved March 18, 2017, from http://www.phystech.org/keycomponents/pck.cfm

Pinamang, O. C. (2017). Pre-service Teachers Content Knowledge and Pedagogical Content Knowledge in Teaching Geometric Transformation. *African Journal of Educational Studies in Mathematics and Sciences, 13(6)*: 63 – 71.

PISA (2003). Technology in Teaching. Retrieved May 7, 2018, from http://www.pisa.oecd.org/science/structure.html

Plevyak, L. (2007). What do Pre-service Teachers Learn in an Inquiry-Based Science Methods Course? *Journal of Elementary Science Education. 9(1)*: 1 – 13.

Pollard, A., Triggs, P., Broadfoot, P., McNess, E. & Osborn, M. (2008). What Pupils say: Changing Policy and Practice in Primary Education. *Journal of Educational Change, 4(1)*: 81 – 87.

Posner, G. J. (1992). Models of curriculum planning. Retieved March 12, 2014 from https://www.scrib.com/document/133851183/models-of-curriculum-planning-posner

Queensland College of Teachers (2012). Teacher registration. Retrieved February 8, 2018 from http://teach.qld.gov.an/study-teaching/professional-requirements.

Quint, J. (2011). Professional development for teachers. Retrieved August 4, 2017 from https://www.mdrc.org/publication/professional-development-teachers.

Ramma, Y. (2017). Teaching and learning physics using technology: making a case for effective domain. Retrieved March 18, 2017, from www.tandfouline.com/doi/full/10.1080/20004508.2017.1343600

Ramsey, G. P., Nemeth, M. M. & Haberkon, D. (2013). Physics Pedagogy and Assessment in Secondary Schools in th US. Retrieved March 2, 2016 from https://arxiv.org/pdf/1305.4576

Redish, E. F. (2003). *Teaching Physics with the Physics Suite.* New York: John Wiley & Sons.

Ren, C. N. (2002). Investigation and Analysis of Senior Middle School Students Physical Study (in Chinese). *Journal of Hubei Normal University* (National Science), *22 (13)*: 82-88.

Republic of Kenya (2008). *Science Technology and Innovation Policy*. Nairobi: Government Press.

Rice, J. L. (2003). *Teacher Quality: Understanding the Effectiveness of Teacher Attributes*. Washington DC: Economic Policy Institute.

Richard, V. & Thousand, J. (2016). *The Inclusive Education Checklist: A Self – Assessment of Best Practices*. National Professional Resources Inc. Dude Publishing.

Rios, J. & Madhavan, S. (2002). Guide to Adopting Technology in Physics Classroom. *The Physics Teacher, 2(38*): 94-97.

Rogers, T. (2007). Shortcomings of high school physics classes. Retrieved July 5, 2014, from www.intuitor.com/physics/physics shortcomings.php

Romain, P. L. (2015). Conflict of interest in research. Retrieved May 10, 2016 from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4596167/

Rosenthal, I. G. (2000). New Teachers and Technology: Are they Prepared? *Technology and Learning, 19(8):* 22 – 28.

Sajjad, S. (2010). Effective teaching methods at higher education level. Retrieved August 24, 2014, from www.usfca.edu/ess/sym2001/PDFbooks/

Sadowska, M. & Kaminska, A. (2010). Problems in teaching physics in primary and secondary schools as seen by young polish teachers. Retrieved July 5, 2014 from www.unireims.fri/site/evenement/girep-ICPE-mptl-2010-reims-international-conference

Schaff, C.S. (2006). A Rasch Model Analysis of Standard for Teacher Competency in Educational Assessment of Student using the Classroom Assessment Inventory. USA: The Northern Illinois University.

Schneider, C. & Gowan, P. (2013). Investigating Teacher' Skills in Interpretting Evidence of Student Learning. *Journal of Measurement in Education, 26(3)*: 58 – 65.

Schwartz, M. S. (2015). Khan Academy: The Illusion of Understanding. *Journal of Asynchronous Learning Network, 17(4)*:67 – 72.

Seidman, I. (2006). *Interviewing in Qualitative Research: A Guide for Researchers in Education and Social Sciences*, (3rd ed). New York, USA: Teachers college press.

Shaban, F. (2014). Curriculum Evaluation Using Tylers's Goal Attainment Model or Objective-Centred Model. Retrieved May 2, 2015 from https://kibogoji.com/.../curriculum-evaluation-using-tylers-goal-attainment-model-or-objective-centred-model

Sharma, A. M., Lanum, L., & Suarez, B. (2008). *A Community Needs Assessment Guide*. Loyola; University of Chicago.

Sharma, M. C. (2017). Approaches and Methods of Teaching Science. Retrieved June 6, 2017 from egyankosh.ac.in/bitstream/123456789/6667/1/unit-2.pdf

Shelly, G., Gunter, G. & Gunter, R. (2012). Teachers discovering computers: Integrating technology in a connected world. Retrieved May, 8 2016 from http://www.amazon.com/Teachers-Discovering...Technology/dp/1133526551

Shongwe, M. & Ocholla, D. (2009). *A Tracer Study of LIS Graduates at the University of Zululand*. Unpublished project work at the Department of Information studies: University of Zululand.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57(1)*: 1 – 22.

Silva, A. (2017). Simulating Electrical Circuits with an electronic spreadsheet. *Computers and Education, 22(4)*, 345 – 353.

Simmons, P. E., Emory, A., Carter, T., Coker, T., Finnegan, B., Crockett, D. (1999). Beginning Teachers: Beliefs and Classroom Actions. *Journal of Research in Science Teaching, 36(4):* 930 – 954.

SMASSE (2008). Records of discussion between Japan International Cooperation Agency and the Government of Kenya on Japanese Technical Cooperation for the SMASSE Project. Nairobi: Government of Kenya.

Sokolowska, D. & Michelin, M. (2018). The role of laboratory work in improving physics teaching and learning. Retrieved December, 2 2018 from https://www.springer.com/la/book/9783319961835

Sonza, S. & Elia, M. (2013). *Physics Teachers Attitudes*: *How Do Theory Affect the Reality of Classroom and Models for Change*. Brazil: Federal University of Rio de Janeiro.

Stecker, P. M., Fuchs, L. S., & Fuchs, D. (2005). Using curriculum-based measurement to improve student achievement: Review of research. *Psychology in the Schools*, 42, 795–819.

Stephanic, E. (2014). Perceptions and Influences behind Teaching Practices. Do Teachers teach as they were taught? Unpublished phD Thesis. Brigham Young University.

Stiggins, R. J & Conklin, N. F. (1992). *In Teachers Hands, Investigating the Practices of Classroom Assessment*. Albany: State University of New York Press.

Sue, B. & Michael, P. (2014). Peer assessment in physics. Retrieved January 27th, 2017 from https://www2.warwick.ac.uk/fac/cross_facliatl/funding/fundedprojects/ fellowships/be ll _final_report_supplemental.pdf

Sullivan, G. & Anthony, A. (2013). Analyzing and Interpretting Data from Likert – Type Scales. *Journal of Graduate Medical Education. 5(4)*: 541 – 542.

Taylor, J. A. & Dana, T. M. (2003). Improving physics teacher preparation. Retrieve August 10, 2014, from phy.ilstu.edu/jpteo/issues/jpteo1(4)mar03.pdt.

Teacher Education in Sub- Saharan Africa (2016). In – service teacher education in Sub-saharan africa. Retrieved June 2, 2017 from www.tessafrica.net

Teachers Service Commission (2012). Teachers Service Commission Act No. 20 of 2012. Retrieved May 2, 2015 from https://www.tsc.go.ke/index.php/media-centre/dowmloads/category/35-tsc-act

Tezer, M. (2015). Engineering Students' Self- efficacy related to Physics Learning. *Journal of Baltic Science Education, 14 (3):* 311 – 326.

Thabane, L. (2010). A tutorial on pilot studies: The what, why and how – Research Gate. Retrieved April 22, 2016 from http://www.biomedcentral.com/1471-2288/10//

The New Zealand (2016). Implementing an Inclusive Curriculum. Retrieved March 18, 2017, from nzcurriculum.tki.org.nz/inclusive-practices/Implementing-an-inclucive-curriculum

The Teaching Council (2011). *Initial Teacher Education: criteria and guidelines for programmes providers.* Ireland: Maynooth, co. Kildare.

The Teaching council. (2007).Code of Professional Conduct for Teachers. Retrieved February 15, 2018 from www. education. ie

Tofade, T., Elsner, J. & Haines, S. (2013). Best Practice Strategies for Effective use of Question as a Teaching Tool. *Americal Journal of pharmaceutical Education, 77(7)*: 155 – 161.

Tomi, J. (2012). Teaching Physics in Higher Education: Aims, Experiences and strategies. Retrived January 8, 2015 from www2.physics.ox.ac.uk/sites/default/files/2011.10.08/tomi_johnson_ developing_learning and teaching_po_12684.pdf

Trilling, B. & Fadel, C. (2012). The 21st Century Skills: learning for life in our times. The Amazon Book Review.

TSC (2016). TPAD tool for teachers. Retrieved August 12, 2017 from https://www.tsc.go.ke/.../88-performance-management-pc-and-tpad2019?...tpad

Tyler, R. W. (1949). *Basic Principles of Curriculum and Instruction.* Chicago: Chicago University Press.

UNESCO (2012). *World Data on Education*. Retrieved August 10, 2014, from http: //www.ibe.unesco.org/

UNESCO (2007). Uses of T.V and radio in education: ICT in Education Newsletter.

UN-ICT (2013). Information Communications Technologies (ICT) – The United

Nations. Retrieved August 2, 2017 from http;www.un.org/sc/ctc/focus-areas/information-and-communications-technology.

University of Twente (2014). ELAN'S Teacher Education and Research Programmes. Twente.

US Department of Education (2016). Use of Technology in Teaching and Learning. Retrieved March 18, 2017, from https://www.ed.gov/oii-news/use-technology-teaching-and-learning

Utib-Abasi, S. (2011). The Status of Material Resources for Effective Teaching of Physics in Secondary Schools in Akwa- Ibom State in Nigeria. *An International Multidisciplinary Journal*, *5(4)*: 242 – 249.

Van Driel, J.& Berry, A. (2012). Teacher Professional Development on Pedagogical Content Knowledge, *Journal of Educational Research. 41(1):* 26 – 28.

Vingsle, C. (2014). Formative assessment: Teacher knowledge and skills to make it happen. Retrieved June 5, 2016 from https://umu.diva-portal.org/smash/get/diva2:735415/FULLTEXT01.pdf

Vosniadou, S. (2009). Conceptual Change and Education. Retrieved March 2, 2016 from http://www.researchgate.net/.../247702015_conceptual_change_and_Education

Wambugu, P., Changeiywo, J. & Ndiritu, F. (2013). Effects of Experiential Co-operative Concept Mapping Pedagogical Approach on Secondary School Students' Achievement in Physics in Nyeri County, Kenya. *Journal of Education and Practice*, *5(15)*: 74- 83.

Wanzala, O. (2016 April 7th). *Education Cabinet Secretary Matiangi set to unveil Team to steer Curriculum Reforms*. Daily Nation, pp 27. Nairobi: Nation Media Group.

Wartawan, P. G. (2017). Effect of using portfolio assessment to improve scientific attitude of students learning physics in high school. Retrieved July 2, 2018 from https://doi.org/10.1051/shsconf/20184200118.

Wayne, A. J. & Youngs, P. (2003). Teacher characteristics and student achievement gains: A review. Retrieved June 6, 2017 from https://www.jstor.org/stable/3516044

Wenger, E. (1998). *Communities of Practice*. New York: Cambrigde University press.

West Lothian Council Educational Psychology Service (2017). Effective Questionning. Retrieved August 3, 2018 from https://www.westlothian.gov.uk/media/268/Questioning/pdf/Questioning.pdf

Westera, W. (2015). Reframing the role of Educational Media Technologies. *Quarterly Review of Distance Education, 16(2)*: 19 – 32.

White, G. (2008). ICT trends in education. Digital learning research. Retrieved March 2, 2016 from http://reseach.acr.edu.au/digital_learning/2

Wiema, C. (2007). Science Education in the 21st Century: using the tools of science to teach science. Presentation at the Science Education forum. University of British Columbia.

Wiema, C. & Perkins, K. (2005). Transforming Physics Education. *Journal of Physics Today, 58(11):* 36-48.

William D. (2006). What do research say the benefits of formative assessment are? Retrieved June 5, 2016 from https://www.mononagrove.org/wiliamResearchonFormativeAssessment.pdf

William, D. (2004). Assessment and the regulation of learning. Paper presented at invited symposium on what does it mean for classroom assessment to be valid? Reliable?. The annual meeting of the national council of measurement in education, San Diego, CA.

Wilson, S. M. & Wineburg, T. (1988). Peering at History Through Different Lenses: The Role of Disciplinary Perspectives in Teaching History. *Teachers College Records. 89(4)*: 524 – 539.

World Bank (2007). Developing Science and Mathematics and ICT Education in SSA. Pattern and providing practice. World Bank working paper No. 101, Washington D.C.

Yashwantrao, R., Ajeevsing, B.,Mike, W. & Pascal, S.(2017). Teaching and Learning Physics using technology: Making a case for effective domain. Retrieved September 2, 2017 from homepage: http://www.tandfontline.com/loi/zeduzo.

Zahra, H. & Ali, H. (2014). The Effect of Information Technology in Teaching Physics

Courses. *Eurasian Proceeding of Educational and Social Sciences, 1(1)*: 391-396.

Zerub, A. R. & Rubba, P. A. (1983). Development and Validation of an Inventory to Assess Science Teachers Needs in Developing Countries. *Journal of Research in Science Teaching, 20(9)* : 867 – 887.

Zhicheny, Z. & Judith, A. (2003). Classroom Assessment Practices and Teachers` Self Perceived Assessment Skills. *Journal of Applied Measurement in Education, 16(4*): 323-342.

Zhu, Z. (2013). Chinese Secondary Physics Teachers' Beliefs and the ways in which the Beliefs Influence their Classroom Practices . *Journal of Hubei Normal University* (National Science), *22 (13)*: 82-88.

Zhu, Z. (2007). Learning Content, Physics Self-efficacy and Female Students Physics Course- Taking. *Journal of International Education, 8 (2)*: 104-112.

APPENDICES

APPENDIX A: QUESTIONNAIRE FOR PHYSICS STUDENT TEACHERS

Introduction

I am a post-graduate student at Maseno University, carrying out research that aims to review physics teacher education programmes as offered by the public universities in Kenya. This is to make the programmes more relevant to teaching of physics in secondary schools. I am interested in your views on various aspects teacher education and on secondary school physics instruction that you are participating in. Your responses will be kept confidential and used only for the purpose of this study. I request you to spend a few minutes of your time to respond to the issues.
If you accept to fill in the questionnaire, please sign in the space provided below.

Signature ________________________________ Date _________________________

Definition
Pedagogic skills: Include subject matter knowledge, assessment skills, communication skills, skills in use of resource materials and skills in use of information technology (IT) - that are requisite for effective teaching of secondary school physics.

Students with learning disabilities: Students with special educational needs in mainstream classrooms such as; impairments in perceiving, phonological processing, memory, language processing, planning, vision, attention and decision making.

Background information
Please tick (√) against your choice or write briefly in the blank spaces provided below each item.

1. Name of the University: Moi ☐ Kenyatta ☐ Egerton ☐ UoN ☐ MMUST ☐

2. Name of your teaching practice school: _____________________________________
3. Name of the teaching practice region: ______________________________________

4. Category of the T/P school: National ☐ extra-county ☐ County ☐ Sub- County ☐

5. Gender of the respondent Male ☐ Female ☐

6. By responding to a) or b) below, what are your teaching subjects?

   a) Major _________________________ Minor ___________________________

   b) Equal Units_______________ ____________________ ____________________

7. What did you attain at the Kenya Certificate of Secondary Education (KCSE) examination? Mean grade _____________ Grade in physics ________________

8. a) Tick (√) in the appropriate boxes below to indicate the three most preferred methods of teaching that should be emphasised in physics teacher education programmes for your acquisition of pedagogic skills.

Student demonstration ☐ Lecture method ☐ Use of charts and Tables ☐

Interactive lecture ☐ Peer teaching ☐ Project work ☐

Teacher demonstration ☐ Experimentation ☐ Use of IT in teaching ☐

Use of strategies to cater for students with learning disabilities ☐

9. b) Tick (√) in the appropriate boxes below to indicate the three most preferred assessment strategies that should be emphasised in physics teacher education programmes for your acquisition of pedagogic skills.

Assessment of group work ☐ Laboratory reports ☐ peer assessment ☐

Use of end of topic quizzes ☐ Portfolio analysis ☐ Question and answer ☐

Assessment of project work ☐ Standard examinations ☐ student self-assessment ☐

Use of Information Technology in assessment of physics ☐

10. What gaps did you notice on the following regarding physics teacher education programmes that you undertook at the university in relation to your acquisition of pedagogic skills?

a) Objectives

____

____

____

b) Content

____

____

____

c) Methods of teaching

____

____

____

Assessment Strategies

____

____

____

11. What are your suggestions for improvement of the following areas of physics teacher education programmes as offered by your university, in order to make training more relevant to your acquisition of pedagogic skills?

a) Objectives

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b) Content

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c) Methods of teaching

____

____

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d) Assessment strategies

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____

Training Programme of Physics Teachers

Below are four areas of Physics Teacher Education Programmes namely objectives, content, methods of teaching and assessment strategies. On a five-point Likert scale, tick (√) appropriately in the respective columns to indicate the relevance of each item in relation to pedagogic skills labelled A, B, C, D and E.

Key: VR- Very Relevant, R- Relevant, NS- Not Sure, I- Irrelevant, VR- Very Irrelevant

12	**Objectives of Physics Teacher Education**	**VR**	**R**	**NS**	**I**	**VI**
A	**For Acquisition of Subject Matter Knowledge**					
	To produce teachers who can effectively teach two subjects at secondary school level.					
	To produce graduates who can participate in development of physics knowledge and processes.					

		VR	R	NS	I	VI
	To produce graduates who can contribute towards research in physics and education.					
	To produce teachers who can effectively implement secondary school physics syllabus.					
	To produce teachers who can implement secondary school curriculum through organizing and executing relevant strategies and processes in curriculum implementation.					
B	**For Acquisition of Assessment Skills**					
	To produce teachers who can compile test items for secondary school physics students.					
	To produce teachers who organize and administer test items for secondary school physics students.					
	To produce teachers who can construct test items for secondary school physics students.					
C	**For Acquisition of Communication Skills**					
	To produce teachers who are professionally committed to teaching and can pursue further professional development.					
	To produce graduate who manage learners from varied biological, social, cultural and ecological backgrounds.					
	To produce teachers who can effectively execute class control and manage school set ups as social gathering.					
D	**For Acquisition of Skills in Use of Resource Materials**					
	To produce graduates who can select, design and use educational media resources effectively.					
	To produce teachers who can effectively manage physics laboratory equipment.					
	To produce teachers who can effectively manage resources in physics.					
E	**For Acquisition of Skills in Use of Information Technology (IT)**					
	To produce teachers who can effectively utilise IT in teaching physics					
	To produce teachers who can effectively utilise IT in assessment of physics					
	To produce teachers who can effectively utilise IT in keeping records in physics					
13	**Content in physics teacher education**					

A	For Acquisition of Subject Matter Knowledge	VR	R	NS	I	VI
	Mechanics					
	Electricity and Magnetism I					
	Optics					
	Thermal Physics					
	Dynamics					
	Electricity and Magnetism II					
	Oscillations and Waves					
	Empirical Ideas of Quantum Physics and Relativity					
	Introduction to Solid State Physics					
	Thermodynamics					
	Quantum Mechanics I					
	Classical Mechanics					
	Solid State Physics					
	Statistical Mechanics					
	Quantum Mechanics II					
	Electrodynamics					
B	**For Acquisition of Assessment Skills**					
	General Methods of Teaching					
	Curriculum Development					
	Tests and Measurements					
	Special Methods of Teaching Physics					
	Teaching Practice					
	Project Work while Teaching Practice					
C	**For Acquisition of Communication Skills**					
	Communication Skills I					
	Communication Skills II					
	Quantitative Skills					
	State, Society and Development					
	Entrepreneurship					
	HIV and AIDS Instruction					
	Research Methodology					
	General Methods of Teaching					
	Introduction to Psychology					
	Human Growth and Development					
	Human Behaviour, Guidance & Counselling					
	Philosophy of Education					
	History of Education					
	Introduction to Logic and Critical Thinking					
	Sociology & Comparative Education of Education					

		VR	R	NS	I	VI
	Environmental Education					
	Educational Administration Theories and Institutional Operations					
	Planning and Economics of Education					
	Introduction to Special Needs Education					
	Teaching Practice					
D	**For Acquisition of Skills in Use of Resource Materials**					
	Educational Media and Resources					
	Educational Technology					
	Instructional Technology and Media Practices					
E	**For Acquisition of Skills in Use of Information Technology**					
	Introduction to Computers					
	Introduction to Spread sheets and Databases					
	Information Systems Analysis and Design					
	Web Design and Publishing					
	Database Systems					
	Management Information Systems					
	Internet Computing					
	Multimedia Graphics					
	Electronic Commerce					
	Statistical Analysis with SPSS					
	Information Technology and Society					
	Human Computer Interactions (HCI)					
	Information Systems Application					
	Internet Controls and Security issues					
	Teaching Practice					
	Project Work while Teaching Practice					
14	**Methods of Teaching in Physics Teacher Education Programmes**					
A	**For Acquisition of Subject Matter Knowledge**					
	Lecture method					
	Interactive lecture					
	Experimentation					
	Laboratory reports					
	Project work					
	Students demonstration					
	Teacher demonstration					
B	**For Acquisition of Assessment Skills**					
	Lecture method					
	Interactive lecture					

		VR	R	NS	I	VI
	Experimentation					
	Laboratory reports					
	Project work					
	Students demonstration					
	Teacher demonstration					
C	**For Acquisition of Communication Skills**					
	Lecture method					
	Interactive lecture					
	Teacher demonstration					
	Student demonstration					
	Use of strategies that cater for students with learning disabilities					
	Peer teaching					
D	**For Acquisition of Skills in use of Resource Materials**					
	Interactive lecture					
	Teacher demonstration					
	Student demonstration					
	Group work					
	Use of strategies to cater for students with learning disabilities					
	Peer teaching					
E	**For Acquisition of Skills in use of Information Technology**					
	Experimentation					
	Project work					
	Use of Chalk boards					
	Charts and Tables					
	Use of computer software					
	Use of projected slides					
	Use of computer simulations					
	Use of Information Technology in teaching physics					
	Use of Information Technology in assessment of physics					
15	**Assessment Strategies in Physics Teacher Education Programmes**					
A	**For Acquisition of Subject Matter Knowledge**					
	Assessment by observation					
	Questioning					
	Use of laboratory reports					
	Use of written tasks in assessment					

		VR	R	NS	I	VI
	Assessment of group work					
	Development of assessment items					
	Peer assessment					
	Students self-assessment					
	Portfolio analysis					
	Project work					
B	**For Acquisition of Assessment Skills**					
	Assessment by observation					
	Questioning					
	Construction of assessment items					
	Adoption of assessment items from previous examinations					
	Written tasks in assessing students					
	Use of group work in assessment					
	Peer assessment					
	Students self-assessment					
	Portfolio analysis					
C	**For Acquisition of Communication Skills**					
	Questioning					
	Assess students as they work in groups					
	Students assessing their own work					
	Use of written tasks in assessing students					
	Use of assessment strategies to cater for students with learning disabilities					
D	**For Acquisition of Skills in use of Resource Materials**					
	Use of laboratory reports to assess students in physics instruction					
	Use of laboratory reports to assess students in physics examinations					
	Use of project work in assessment					
	Use of portfolio analysis					
E	**For Acquisition of Skills in use of Information Technology**					
	Questioning					
	Use of information technology in assessment of physics					
	Use of computer software in assessment of physics					
	Use of web technologies in assessment of physics					
	Use of assessment strategies to cater for students with learning disabilities					

THANK YOU

APPENDIX B: QUESTIONNAIRE FOR SECONDARY SCHOOL HEAD TEACHERS

Introduction

Your school has been selected to participate in a research on "Evaluation of Physics Teacher Education as Offered by Public Universities in Kenya." Physics student teachers, Heads of physics subjects and your self are requested to participate in order to assist in completion of the study. If you approve of your school's participation, I will thereafter proceed to contact the respective teachers for their involvement. If you have any questions or require any clarifications, you are free to ask. All responses made will be used purely for purposes of this research and kept confidential.

If you accept to fill in the questionnaire and consent to the participation of physics student teachers and physics head of Subject, please sign in the space provided below.

Signature ________________________________ Date _________________________

Background information

Please tick (√) against your choice or write briefly in the blank spaces provided below each item.

1. Name of your school: ____

2. Category of your school: a) National ☐ b) extra-county ☐
   c) County ☐ d) Sub-County ☐

3. Name of the public university that trained the physics student teacher:

Moi ☐ Kenyatta ☐ Egerton ☐ UoN ☐ MMUST ☐

Competencies of Physics Student Teachers

4. On the scale given below, please tick (√) to rate the physics student teacher in your school on the following:

a) Communication in classroom
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very Poor ☐

b) Teaching competence
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very poor ☐

c) Use of material resources
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very Poor ☐

d) General management skills
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very poor ☐

e) Use of IT in teaching physics
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very Poor ☐

f) Use of IT in assessment of physics
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very poor ☐

g) Management of behaviour in classroom
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very Poor ☐

h) Integration in school system
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very poor ☐

i) Collaboration with other teachers
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very Poor ☐

j) Contribution towards attainment of school values
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very poor ☐

k) Use of computer software in assessment of physics
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very Poor ☐

l) Use of project work in assessment of physics
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very poor ☐

m) Use of web technology in assessment of physics
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very Poor ☐

n) Use of a variety of teaching methods
- Very good ☐
- Good ☐
- Not sure ☐
- Poor ☐
- Very poor ☐

5. What gaps have you noticed regarding secondary school physics instruction as conducted by the student teacher on the following aspect?

a) Implementation of the objectives of secondary school physics

____

____

____

b) Understanding of content in secondary school physics

____

____

____

c) Methods of teaching in secondary school physics

____

____

____

d) Assessment of secondary school physics

____

____

____

6. What are your suggestions for improvement of the following areas of physics teacher education programmes as offered by public universities, in order to make training more relevant to secondary school physics instruction?

a) Objectives

____

____

____

b) Content

____

____

____

c) Methods of teaching

____

____

____

d) Assessment strategies

____

____

____

____

THANK YOU

APPENDIX C: QUESTIONNAIRE FOR HEADS OF PHYSICS SUBJECT

Introduction

You are requested to participate in a research that seeks to evaluate physics teacher education programmes as offered by public universities in Kenya. This questionnaire is designed to collect information about physics instruction in your school as it is conducted by the teacher on teaching practice. The information you provide will be used purely for the purpose of the research and all the responses will be kept confidential.

If you accept to fill in the questionnaire, please sign in the space provided below.

Signature ________________________________ Date _________________________

Definition

Pedagogic skills: Includes subject matter knowledge, assessment skills, communication skills, skills in use of resource material and skills in use of information Technology (IT) to be relayed by the physics student teacher.

Students with Learning Disabilities - Students with special educational needs in mainstream classrooms such as; impairments in perceiving, phonological processing, memory, language processing, planning, vision, attention and decision making.

Background Information

1.Name of your school:____

2. Category of the school a) National ☐ b) extra-county ☐
c) County ☐ d) Sub-County ☐

3. Name of the university that trained the physics student teacher:
Moi ☐ Kenyatta ☐ Egerton ☐ UoN ☐ MMUST ☐

Secondary School Physics Instruction

Tick (√) in the appropriate box to rate the physics student teacher in your school, on his/her engagement with the following in physics instruction.

		Very Good	**Good**	**Average**	**Poor**	**Very Poor**
4	**Objectives of Secondary School Physics**					
	An understanding of the secondary school physics objectives					
	Clarity in stating objectives for each lesson taught					
	Extent of stating objectives for laboratory work					
	Link between stated objectives and classroom practice					
	Clarity of stating objectives on the Use of instructional resources					

		Very Good	Good	Average	Poor	Very Poor
	Link between stated objections and selection of resource material					
	Relevance of stated objectives to use of Information Technology					
	Use of resources to attain the stated objectives					
5	**Content in Secondary School Physics**					
A	**Engagement with subject Matter Knowledge**					
	Physics content knowledge					
	Ability to make inference to physics content knowledge					
	Level of engagement with physics content knowledge during instruction					
	Level of understanding of emerging issues in physics					
	Relating of physics content to real life situations					
	Ability to discuss ideas involving physics content					
B	**Engagement with Assessment in Physics**					
	Use of end of topic tests					
	Use of standard tests					
	Use of a variety of assessment strategies in physics instruction					
	Use of feedback from assessment to adjust instruction					
	Assessment of laboratory work					
	Construction of assessment items for students					
	Use of project work as an assessment strategy					
	Assessment of students with learning disabilities					
	Performance of learners in physics examinations					
C	**Communication Skills of the Student Teacher**					
	Verbal communication					
	Non-verbal communication					
	Classroom organisation					
	Classroom management					
	Management of students with learning disabilities					
	Management of students with problems of health					
	Management of students with problems of drug abuse					
	Management of students with problems of discipline					
	Critical thinking skills					
	Problem solving skills					
D	**Student Teacher's use of Resource Material**					
	Selection of resource material					
	Preparation of teaching aids					

		Very Good	Good	Average	Poor	Very Poor
	Use of physics models					
	Improvisation in teaching of physics					
	Utilization of physics laboratory equipment					
	Use of resources to cater for students with learning disabilities					
E	**Student Teacher's use of Information Technology**					
	Use of information technology in teaching of physics					
	Use of information technology in assessment of physics					
	Use of information technology in developing physics project work					

Tick (√) appropriately in the respective columns to indicate the frequency with which the physics student teacher in your school uses each of the strategies in physics instruction.

Key: VF- Very Frequently, F- Frequently, NS- Not Sure, R- Rarely, VR- Very Rarely

6	**Methods of Teaching in Secondary School Physics**	**VF**	**F**	**NS**	**R**	**VR**
A	**For Relaying of Subject Matter Knowledge**					
	Lecture method					
	Interactive lecture					
	Experimentation					
	Laboratory reports					
	Project work					
	Use of a variety of teaching strategies					
	Student demonstration					
	Teacher demonstration					
	Use of question and answer method					
	Use of teaching strategies to cater for students with learning disabilities					
	Level of engagement in manipulative skills					
B	**To Enhance Communication during Physics Instruction**					
	Lecture method					
	Interactive lecture					
	Use of a variety of strategies in teaching					
	Student demonstration					
	Teacher demonstration					
	Use of question and answer method					
	Use of strategies to cater for students with learning disabilities					

C	**To Enhance use of Resource Material in Physics Instruction**	**VF**	**F**	**NS**	**R**	**VR**
	Use of physics models					
	Improvisation in teaching of physics					
	Utilisation of physics laboratory facilities					
	Use of resources to cater for students with learning disabilities					
D	**To Enhance use of Information Technology**					
	Use of computer software in physics instruction					
	Use of projected slides in teaching physics					
	Use of computer simulations in teaching physics					
	Use of information technology in teaching of physics					
	Use of information technology in assessment of physics					
7	**Assessment Strategies in Secondary School Physics**					
A	**To Enhance Assessment in Physics Instruction**					
	Use of end of topic test during teaching					
	Use of standard examinations					
	Use of a variety of assessment strategies in physics instruction					
	Use of feedback from assessment to adjust teaching methods					
	Construction of assessment items for students					
	Use of peer assessment					
	Use of Portfolio analysis					
	Use of feedback from assessment to adjust teaching resources					
	Use of project work as an assessment strategy					

8. a) Tick (√) in the appropriate boxes below to indicate the three most preferred methods of teaching that should be emphasised in physics teacher education programmes for acquisition of pedagogic skills by the student teacher.

Student demonstration ☐ Lecture method ☐ Use of charts and Tables ☐

Interactive lecture ☐ Peer teaching ☐ Project work ☐

Teacher demonstration ☐ Experimentation ☐ Use of IT in teaching ☐

Use of models to cater for students with learning disabilities ☐

9. b) Tick (√) in the appropriate boxes below to indicate the three most preferred assessment strategies that should be emphasised in physics teacher education programmes for acquisition of pedagogic skills by the student teacher

Assessment of group work ☐ Laboratory reports ☐ peer assessment ☐

Use of end of topic quizzes ☐ Portfolio analysis ☐ Question and answer ☐

Assessment of project work ☐ Standard examinations ☐ student self-assessment ☐

Use of Information Technology in assessment of physics ☐

10. What gaps have you noticed with the physics student teacher in your school with regards to secondary school physics instruction on the following?

a) Engagement with objectives of secondary school physics

____

____

b) Delivery of content in secondary school physics

____

____

c) Use of methods of teaching in secondary school physics

____

____

d) Use of assessment strategies in secondary school physics

____

____

11. What are your suggestions for improvement of the following areas of physics teacher education programmes as offered by public universities in order for physics student teachers to acquire pedagogic skills needed for effective instruction?

a) Objectives

____

____

b) Content

____

____

c) Methods of teaching

____

____

d) Assessment strategies

____

____

THANK YOU

APPENDIX D: QUESTIONNAIRE FOR PHYSICS TEACHER TRAINERS

Introduction

I am a post graduate student at Maseno University, and carrying out research that aims to evaluate physics teacher education programmes as offered by public universities in Kenya. I am interested in your views on four aspects of physics teacher education namely objectives, content, methods of teaching and assessment strategies. Your responses will be kept confidential and used only for the purpose of the study. My request is that you spend a few minutes of your time to respond to the issues. The definition below may be of importance.

Definitions

Physics Teacher Education refers to all the undergraduate courses offered by public universities to physics teacher trainees who are taught in the group of B.Ed (Science).

Methods of Teaching refer to organisation of educational experiences that includes teaching strategies, media resources and information technology.

Pedagogic Skills Includes subject matter knowledge, assessment skills, communication skills, skills in use of resource material and skills in use of information Technology (IT) needed by student teachers for effective secondary school physics instruction.

Students with Learning Disabilities refers to students with special educational needs in mainstream secondary school classrooms such as; impairments in perceiving, phonological processing, memory, language processing, planning, vision, attention and decision making.
If you accept to fill in the questionnaire, please sign in the space provided below.

Signature ______________________________ Date ____________________________

SECTION A

In this section, please respond to each of the statements made

Background Information

Please tick (√) against your choice or write briefly in the blank spaces provided below each item to describe your situation or views.

1. Name of your university:

Moi ☐ Kenyatta ☐ Egerton ☐ UoN ☐ MMUST ☐

1. Name of your Department:____

2. Your current designation: Tutorial Fellow ☐ Assistant Lecturer ☐
   Lecturer ☐ Senior Lecturer ☐
   Associate Professor ☐ Professor ☐

3. What is your university teaching experience in years ______________________________

Training of Teachers of Physics

4. List the title of the course(s) that you teach. In reference objectives, methods of teaching and assessment strategies in each course, tick (√) in the respective box to indicate how relevance each aspect of the course (s) is to acquisition of pedagogic skills by physics student teachers.

KEY: VR-Very Relevant, R-Relevant, NS-Not Sure, I- Irrelevant, VR-Very Irrelevant

a) Objectives

Course (s)	**Rating Scale**				
	VR	**R**	**NS**	**I**	**VI**

b) Methods of teaching

Course (s)	**Rating Scale**				
	VR	**R**	**NS**	**I**	**VI**

c) Assessment strategies

Course (s)	**Rating Scale**				
	VR	**R**	**NS**	**I**	**VI**

5. On the basis of the course(s) that you teach, what are your suggestions for Improvement if any, in order to make the course more relevant to acquisition of pedagogic skills by physics student teachers?

    a) Objectives

    ____

    ____

    ____

b) Content

____

____

____

c) Methods of teaching

____

____

____

d) Assessment strategies

____

____

____

6. Below are items on methods of teaching and assessment strategies in physics teacher education programmes. Tick (√) appropriately in the respective columns, to indicate the frequency with which you use each of them in the course(s) that you teach.

Key: VF - Very Frequently, F- Frequently, NS- Not Sure, R - Rarely, VR – Very Rarely

A	**Methods of Teaching in Physics Teacher Education**	**VF**	**F**	**NS**	**R**	**VR**
	Lecture method					
	Interactive lecture					
	Experimentation					
	Teacher demonstration					
	Student demonstration					
	Laboratory reports					
	Research reports					
	Project work					
	Peer teaching					
	Group work					
	Use of chalk boards					
	Charts and tables					
	Use of teaching strategies to cater for students with learning disabilities					
	Use of Information Technology in teaching					
B	**Assessment Strategies in Physics Teacher Education**					
	Assessment by observation					
	Questioning					
	Assess students as they work within groups					
	Use of laboratory reports in assessment					

		VF	F	NS	R	VR
	Peer assessment					
	Construction of assessment items					
	Adoption of assessment items from previous examinations					
	Use of written tasks in assessing students					
	Balance of tasks in examinations to cover aspects of cognitive, affective and psychomotor skills.					
	Use of assessment strategies to cater for students with learning disabilities					
	Use of IT skills in assessment					

SECTION B

In this section, please respond to statements made under your department

Department of Educational Communication, Technology and Curriculum Studies

7. Please indicate the extent of preparedness of the physics student teachers for secondary school physics instruction on the following

a) Lesson plan:
- Highly prepared ☐
- Prepared ☐
- Not sure ☐
- Unprepared ☐
- Very unprepared ☐

b) Schemes of work:
- Highly prepared ☐
- Prepared ☐
- Not sure ☐
- Unprepared ☐
- Very unprepared ☐

c) Lesson preparation
- Highly prepared ☐
- Prepared ☐
- Not sure ☐
- Unprepared ☐
- Very unprepared ☐

d) Introduction of lessons:
- Highly prepared ☐
- Prepared ☐
- Not sure ☐
- Unprepared ☐
- Very unprepared ☐

e) Lesson development:
- Highly prepared ☐
- Prepared ☐
- Not sure ☐
- Unprepared ☐
- Very unprepared ☐

f) Verbal communication
- Highly prepared ☐
- Prepared ☐
- Not sure ☐
- Unprepared ☐
- Very unprepared ☐

g) Non-verbal communication

Highly prepared ☐
Prepared ☐
Not sure ☐
Unprepared ☐
Very unprepared ☐

h) Selection of resource material

Highly prepared ☐
Prepared ☐
Not sure ☐
Unprepared ☐
Very unprepared ☐

i) Use of resource materials

Highly prepared ☐
Prepared ☐
Not sure ☐
Unprepared ☐
Very unprepared ☐

j) Preparation teaching aids

Highly prepared ☐
Prepared ☐
Not sure ☐
Unprepared ☐
Very unprepared ☐

k) Classroom organisation

Highly prepared ☐
Prepared ☐
Not sure ☐
Unprepared ☐
Very unprepared ☐

l) Classroom management

Highly prepared ☐
Prepared ☐
Not sure ☐
Unprepared ☐
Very unprepared ☐

m) Use of physics models

Highly prepared ☐
Prepared ☐
Not sure ☐
Unprepared ☐
Very unprepared ☐

n) Utilization of physics laboratory facilities

Highly prepared ☐
Prepared ☐
Not sure ☐
Unprepared ☐
Very unprepared ☐

p) Use of resources to cater for students with learning disabilities

Highly prepared ☐
Prepared ☐
Not sure ☐
Unprepared ☐
Very unprepared ☐

8. Below are some of the statements on objectives of Physics Teacher Education Programmes. Tick (√) appropriately in the respective columns, to indicate the relevance of each statement to acquisition of pedagogic skills of physics student teachers?

Key: VR – Very Relevant; R - Relevant; NS - Not Sure; I – Irrelevant; VI - Very Irrelevant

NO.	Item	VR	R	NS	I	VI
	Objectives					
A	Produce teachers who are professionally committed to teaching and can pursue further professional development					
B	Produce teachers who can effectively teach two subjects at secondary school level					
C	Produce graduates who can apply teaching methods and strategies to meet educational aims of secondary school physics					
D	Produce graduates who can select, design and use media resources effectively					
E	To produce teachers who can implement secondary school curriculum through organizing and executing relevant strategies and processes in curriculum implementation					
F	Produce graduates who can contribute towards research in education					

9. The courses below are part of the content in Physics Teacher Education Programmes; indicate the relevance of each in relation to acquisition of pedagogic skills of physics student teachers.

Key: VR- Very Relevant, R- Relevant, NS- Not Sure, I- Irrelevant, VR- Very Irrelevant

NO.	Content	VR	R	NS	I	VI
A	General Methods of Teaching					
B	Educational Media and Resources					
C	Curriculum Development					
D	Special Methods of Teaching Physics					
E	Educational Technology					
F	Teaching Practice					

Department of Educational Psychology

10. Below are some of the statements of objectives of Physics Teacher Education Programmes. Tick (√) appropriately in the respective columns, to indicate the relevance of each statement each in relation to acquisition of pedagogic skills of physics student teachers.

Key: VR – Very Relevant; R - Relevant; NS - Not Sure; I – Irrelevant; VI - Very Irrelevant

NO.	Item	VR	R	NS	I	VI
	Objectives					
A	Produce graduate who manage learners from varied biological, social, cultural and ecological backgrounds					
B	Produce teachers who can effectively execute class control during instruction					
C	Produce teachers who can effectively execute behavior management during instruction					
D	Produce teachers who can construct test items for secondary school students					
E	Produce teachers who can organize and administer test items for secondary school students					

11. The courses listed below are part of the content in Physics Teacher Education Programmes. Indicate the relevance of each course in relation to acquisition of pedagogic skills by physics student teachers.

Key: VR – Very Relevant; R - Relevant; NS - Not Sure; I – Irrelevant; VI - Very Irrelevant

NO.	Content	VR	R	NS	I	VI
A	Introduction to Psychology					
B	Human Growth and Development					
C	Human Behaviour, Guidance & Counselling					
D	Educational Tests and Measurements					

Department of Educational Foundations, Planning and Management

12. Below are some of the statements of objectives of Physics Teacher Education Programmes. Tick (√) appropriately in the respective columns, to indicate the relevance of each statement in relation to acquisition of pedagogic skills of physics student teachers.

Key: VR – Very Relevant; R - Relevant; NS - Not Sure; I – Irrelevant; VI - Very Irrelevant

NO.	Item	VR	R	NS	I	VI
	Objectives					
A	Produce graduate who manage learners from varied biological, social, cultural and ecological backgrounds					
B	Produce teachers who can effectively manage classroom set ups as social gathering					
C	Produce teachers who can effectively manage classroom instruction in secondary schools					

13. The courses listed below form part of the content in Physics Teacher Education Programmes, indicate the relevance of each course in relation to acquisition of pedagogic skills of physics student teachers.

NO.	Content	VR	R	NS	I	VI
A	Philosophy of Education					
B	History of Education					
C	Sociology & Comparative Education					
D	Environmental Education					
E	Educational Administration Theories and Institutional Operations					
F	Planning and Economics of Education					

Department of Special Needs Education

14. The course below is part of content in Physics Teacher Education Programmes, indicate the relevance of each in relation to acquisition of pedagogic skills of physics student teachers.

NO.	Content	VR	R	NS	I	VI
A	Introduction to Special Needs Education					

Department of Human Resource and Development

15. The courses listed below form part of the content in Physics Teacher Education Programmes, indicate the relevance of each course in relation to acquisition of pedagogic skills of physics student teachers.

NO.	Content	VR	R	NS	I	VI
A	State Society and Development					
B	Quantitative Skills					
C	Entrepreneurship					
D	Communication Skills I					
E	Communication Skills II					
F	HIV and AIDS Instruction					
G	Logic and Critical Thinking					

Department of Computer Studies and Information Technology

16. Below are some of the statements of objectives of Physics Teacher Education Programmes. Tick (√) appropriately in the respective columns, to indicate the relevance of each statement in relation to acquisition of pedagogic skills of physics student teachers.

Key: VR – Very Relevant; R - Relevant; NS - Not Sure; I – Irrelevant; VI - Very Irrelevant

NO.	Item	VR	S	NS	I	VI
A	To produce teachers who can utilize information Technology effectively during instruction					
B	To produce teachers who can utilize information Technology effectively during assessment					

17. Below are courses that form part of content in Physics Teacher Education Programmes, indicate the relevance of each course each in relation to acquisition of pedagogic skills of physics student teachers.

NO.	Content	VR	R	NS	I	VI
A	Introduction to Computers					
B	Desktop Publishing					
C	Introduction to Spread Sheets and Databases					
D	Information Systems Analysis and Design					
E	Web Design and Publishing					
F	Management of Information Systems					
G	Database System laboratory					
H	Internet Computing					
I	Multimedia and Graphics					
J	Electronic Commerce					
K	Statistical Analysis with SPSS					
L	Information Technology and Society					
M	Internal Control and Security Issues					
N	Human Computer Interaction					
P	Information Systems Application					

Department of Physics

18. Below are some statements on objectives of Physics Teacher Education Programmes. Tick (√) appropriately in the respective columns, to indicate the relevance of each of the statements in relation to acquisition of pedagogic skills of physics student teachers.

Key: VR – Very Relevant; R - Relevant; NS - Not Sure; I – Irrelevant; VI - Very Irrelevant

NO.	Item	VR	R	NS	I	VI
A	Produce teachers who can effectively implement secondary school physics syllabus.					
B	Produce teachers who can effectively manage resources in physics					
C	Produce teachers who can effectively manage physics laboratory processes					

19. Below are courses that form part of content in Physics Teacher Education Programmes, indicate the relevance of each course in relation to acquisition of pedagogic skills of physics student teachers.

Key: VR – Very Relevant; R - Relevant; NS - Not Sure; I – Irrelevant; VI - Very Irrelevant

	Content	VR	R	NS	I	VI
A	Mechanics					
B	Electricity and Magnetism I					
C	Optics					
D	Thermal Physics					
E	Dynamics					
F	Electricity and Magnetism II					
G	Oscillations and Waves					
H	Empirical Ideas of Quantum Physics and Relativity					
I	Thermodynamics					
J	Classical Mechanics					
K	Introduction to Solid State Physics.					
L	Quantum Mechanics I					
M	Solid State Physics					
N	Electrodynamics					
P	Statistical Mechanics					
R	Quantum Mechanics II					

THANK YOU

APPENDIX E: DOCUMENT ANALYSIS GUIDE (DAG)

1. In reference to the Kenya Institute of Curriculum Development (KICD) physics teaching syllabus;

   (a) To what extent are the objectives of secondary school physics catered for in the objectives of physics teacher education programmes?

   (b) To what extent is the content in secondary school physics catered for in the content of physics teacher education programmes?

   (c) To what extent are the methods of teaching in secondary school physics catered for in the methods of teaching in physics teacher education programmes?

   (d) To what extent are assessment strategies in secondary school physics catered for in assessment strategies in physics teacher education programmes?

2. In reference to the secondary school Kenya National Examination Council (KNEC) syllabus;

   (a) To what extent are the objectives of KNEC syllabus catered for in the objectives of physics teacher education programmes?

   (b) To what extent is the content in the KNEC syllabus catered for in the content of physics teacher education programmes?

   (c) To what extent are the methods of teaching in the KNEC syllabus catered for in the methods of teaching in physics teacher education programmes?

   (d) To what extent are assessment strategies in the KNEC syllabus catered for in assessment strategies in physics teacher education programmes?

3. In reference to the physics teacher education programmes, the secondary school KICD physics teaching syllabus and the secondary school KNEC syllabus, what is the extent of congruence on the following aspects;

(a) Objectives

(b) Content

(c) Methods of teaching

(d) Assessment strategies

4. In reference to the Teachers' Performance Appraisal and Development(TPAD) tool, what do the employer expect of physics teachers with regards to the following;

   (a) Attainment of objectives of secondary school physics

   (b) Teachers' level of understanding of content in Secondary school physics

   (c) Methods of teaching in secondary school physics instruction

   (d) Assessment strategies in secondary school physics

END

APPENDIX F: PHYSICS TEACHER EDUCATION PROGRAMMES

1. The Amalgamated Physics Teacher Education Programme used in the Study

Objectives of Physics Teacher Education Programmes

Objectives of Physics Teacher Education for Acquisition of Subject Matter Knowledge

To produce teachers who can effectively teach two subjects at secondary school level

To produce graduates who can participate in development of physics knowledge and processes.

To produce graduates who can contribute towards research in physics and education

To produce teachers who can effectively implement secondary school physics syllabus

To produce teachers who can implement secondary school curriculum through organizing and executing relevant strategies and processes in curriculum implementation

Objectives of Physics Teacher Education for Acquisition of Assessment Skills

To produce teachers who can compile test items for secondary school physics students

To produce teachers who organize and administer test items for secondary school physics students

To produce teachers who can construct test items for secondary school physics students.

Objectives of Physics Teacher Education for Acquisition of Communication Skills

To produce teachers who are professionally committed to teaching and can pursue further professional development

To produce graduate who manage learners from varied biological, social, cultural and ecological backgrounds

To produce teachers who can effectively execute class control and manage school set ups as social gathering.

Objectives of Physics Teacher Education for Acquisition of Skills in use of Resource Materials

To produce graduates who can select, design and use educational media resources effectively

To produce teachers who can effectively manage physics laboratory equipment.

To produce teachers who can effectively manage resources in physics.

Objectives of Physics Teacher Education for Acquisition of Skills in use of Information Technology (IT)

To produce teachers who can effectively utilise IT in teaching physics

To produce teachers who can effectively utilise IT in assessment of physics

To produce teachers who can effectively utilise IT in keeping records in physics

Method of Teaching in Physics Teacher Education Programmes

Lecture method	Interactive lecture
Experimentation	Teacher demonstration
Laboratory reports	Research reports
Project work	Peer teaching
Group work	Use of chalk boards
Charts and tables	Use of Information Technology in teaching
Use of computer software	Use of projected slides
Use of computer simulations	

Use of teaching strategies to cater for students with learning disabilities

Assessment Strategies in Physics Teacher Education Programmes

Assessment by observation	Questioning
Assessment of group work	Peer assessment
Use of laboratory reports in assessment	Construction of assessment items
Use of end of topic quizzes	Use of IT skills in assessment
Students self-assessment	Assessment of project work
Portfolio analysis	Standard examinations

Use of assessment strategies to cater for students with learning disabilities

Content in Physics Teacher Education Programmes

General Methods of Teaching

The nature of teaching and learning; a systems' approach to teaching; teaching methods and strategies; educational aims, goals and objectives; planning for instruction; communication and interaction in the classroom; providing for individual differences; motivation and sustenance of learners' attention and evaluation of learning outcomes.

Educational Media and Resources

Communication Models and Learning**;** barriers to effective communication and how to overcome them; visual communication in learning; verbal and non-verbal communication; introduction to the range of media in teaching and learning; using educational radio and television broadcasts in schools; producing teaching and learning materials in schools; selection and use of print media; management of school multi-media centre; evaluation of educational media; future developments in educational media and resources.

Curriculum Development

Definitions and concepts; the meaning of educational goals and purposes of education; curriculum as a field of study and as a programmesme of instruction; curriculum development process; models of curriculum development; patterns of curriculum organization, stages of curriculum development; principles of curriculum implementation; the process of curriculum implementation; curriculum evaluation; the teacher and the curriculum; curriculum development in Kenya; issues in curriculum development in Kenya; Relevance , strategies and processes; issues in teacher education and teaching profession; universal primary education.

Special Methods of Teaching Physics

An overview of physics education; philosophy of physics education; aim and objectives of the secondary school physics syllabus; strategies in the teaching and learning of Physics; preparation of the scheme of work, lesson plans and record of work covered; preparation, selection and use of resource materials: realia, models, graphics; management of the Physics laboratory; evaluation.

Educational Technology

This unit is divided into two parts, both of which are practical activities for the students in teaching and production of resource materials; The first part covers Educational media practicals: (How to use the chalkboard, graphics, construction of three-dimensional materials, operation of audio-visual equipment, preparation of audio-visual programmes) and the second part covers Microteaching; (Lesson preparation, preparations of audio visual media for the lesson; lesson presentation; skills application-set induction, lecturing, reinforcement, stimulus variation, questioning, providing for learner participation, feedback, closure).

Instructional Technology and Media Practices

Teaching Practice

This is a practical course for students of education. It provides opportunity for the students to practice teaching principles in a real classroom and school environment. Each student is attached for a period of three months to a secondary school and relevant institute of technology or national polytechnic where they work under the guidance of the co-operating teacher and the university supervisor. During this period of attachment to the education institution each student is inducted in the teaching profession and guided and graded in two teaching subjects.

Introduction to Psychology
Psychology and its relationship to education, basic concepts in psychology with a greater emphasis on the principles of human behaviour.
Human Growth and Development
General area of human development with emphasis on adolescent development in terms of biological, social, cultural and ecological factors that influence development. The educational implications that can be drawn from human development. Various theories of human development and their applicability to various communities and cultures. Methods of research in human development.
Human Behaviour, Guidance & Counselling
This course has four sections as follows:

i. **Personality and Group Dynamics**
This section provides a background to both empirical and theoretical considerations of the factors which influence variations in behaviour and changes within the individual. It also examines the origins of group dynamics and the nature of groups and group membership with special emphasis on group pressures, power and influence, leadership groups, group performance, and motivational processes in groups. This will be related to the classroom situation.
ii. **Principles of Guidance and Counselling**
In this section principles of guidance and counselling and the role of guidance workers in the school setting. Theories of counselling, occupational choice, and career development, to be integrated with consideration of practical solutions of adjustment problems of school pupils is also highlighted.
iii. **Learning**
This section introduces learners introduction to the psychology of learning familiarizes them with basic concepts of learning, the nature of the learning process, and the factors which influence this learning process.
iv. **Attitudes and Motivation**
The emphasis in this section is on fundamentals of motivation, human motivation, attitude formation and change, and interpersonal attraction.

Tests and Measurements
Statistics; behavioural statistics, measures of central tendency, measures of variability, co relational and regression analyses, testing of hypotheses. Tests and Measurements; familiarization with the philosophy and nature of educational testing with emphasis on topics such as reliability, validity, and discrimination index, construction of objective and essay tests.
Philosophy of Education
An introduction to philosophy as a discipline of knowledge: the origin, purpose and development of educational philosophy of education as a distinct discipline of knowledge; The concept of education; The content of education; Education and knowledge, education and values; The method of education; The creative and social dimensions of education; The concept of teaching and learning; The teaching of social education and ethics.
History of Education
Development of educational systems, thought and practices throughout history. The role of history of education in teacher training; education in classical times among the ancient Egyptian, Greek, Roman, Indian, Chinese, Hebrew and Arabic societies. Education during the middle ages; rise of universities, the renaissance, reformation and counter-reformation movements; the emergence of states in the 17th and 18th centuries and its influence upon the development of education; modern movements in the 19th and 20th centuries with historical study of the ideas of selected educational thinkers; the theory and practice of African Indigenous education; education in Africa between 1920-1960; the establishment of Western education in Kenya between 1896 - 1963 and the development of education in Kenya 1963 - 2005.
Sociology & Comparative Education of Education

Origins and Evolution of sociology and sociology of Education; Sociology as a discipline of knowledge, its branches and methods of study, the relationship between sociology and other social sciences; sociological theories and their relevance to Education; Education and the socialization process; Education and culture; social stratification and Education; Education opportunity and inequality; Education and Politics; Education and Gender development; Education and development; Education deviance and transformation; Sociological research in Education settings. This course is divided into three distinct parts:

i. Comparative Education encompassing the definition; purpose; significance; historical development and methodological approaches used.
ii. Comparative study of systems of education in Britain; France; Israel; South Africa; Cameroon and East African countries.
iii. Contemporary issues in education such as urbanization, higher education; technical education; teacher education; special education; science education; inspection and supervisory practices; multilingualism; dependence and interdependence in education.

Environmental Education

The Earth; Environment, ecosystems, human factor and the national balance. Environmental crisis; definition, extent, roots and causes. Development and Progress of Environmental Education; Definition, history, objectives and measures. Instruction in Environmental Education; Method and techniques of teaching & evaluation in the secondary school curriculum. Development and Environment; modernization & development, effect of waste gases on atmosphere and climate, pollution, effect of intensive use of resources. Global effects in control of Environmental problems; Kenya's stressed environment and its management. Role of Schools in managing environment.

Educational Administration Theories and Institutional Operations

Introduction to Educational Administration; Educational Administration in Kenya, legal basis of Educational administration. Administration Theories and their relevance Education; planning, vision, mission and objectives, strategic planning. Schools as Organizations. Student Discipline. Ministry of Education Science and Technology structure. Class Control; leadership trait, style, contingency. Theories; power; Authority. Teaching as a profession. Managing Instruction. Office Management. Decision making Techniques.

Planning and Economics of Education

Educational Planning; concept of planning. Historical Background; The process/stages of educational planning, different approaches to planning and their limitations, Demographic aspects in educational planning, measuring access, efficiency and equity, Problems and challenges of Educational Planning in Kenya and other countries. Economic concepts and their relevance to education; Education and Socio-Economic Development; Education and Employment; Efficiency and Equity in Education; The Economics of Non Formal and Recurrent Education; Special Education and Vocational Rehabilitation for the Disabled.

Communication Skills I

Study skills, getting to know the academic environment, planning work, organizing and budgeting time and resources, storing and retrieving information, thinking critically, problem solving, coping with tasks – oriented learning, dealing with facts and opinions, skimming, scanning, summarizing information, note taking and critical reading, listening skills, examination skills.

Communication Skills II

Writing skills, thinking critically, selecting and writing clearly. Analyzing tasks, planning strategies, problem solving, speaking skills, effective speaking, public address, art of persuasion, conducting interviews, Research skills, Effective communication, listening, summarising, in depth questioning, giving and receiving feedback, intercultural communication, non – verbal communication, theory and practice in communication.

Quantitative Skills

Overview of quantification and quantitative skills, Quantitative techniques and education, Summarising data, frequency distributions, averages and measures of dispersion, transformation and combination of data, Basic measures of spatial distribution, point distributions, line distributions and continuous distributions. Decision making, probability and probability statistics, index numbers, time series, budgeting and investment analysis, Network analysis, statistical diagrams.

State, Society and Development

Conceptualization of development, characteristics of transitional societies, Theories of development, African development objectives, Sectorial strategies and development in Kenya since independence in 1963, Strategies for development in Kenya since 1963, Development in the global perspective and international aid.

Entrepreneurship

Introduction, What is entrepreneurship, entrepreneurial process, personality traits of the entrepreneur, motivation and demographics, similarities and differences between entrepreneurs and managers, Intrapreneurship, Entrepreneurial intentions, Implementation of business idea, Business plan.

HIV and Aids Prevention and Management

Introduction, sex and sexuality, HIV/AIDS, Scope of HIV/AIDS pandemic, Global impact of HIV, Types of HIV, History and transmission of HIV, Staging systems for HIV, Prevention care and support, management of HIV and related infections, legal and ethical issues in HIV/AIDS, HIV/AID as a national disaster.

Research Methodology

Introduction to research and research process, research ethics and integrity, critical appraisal; Quantitative research, introduction, study designs and methods, analysis and interpretation of quantitative data, critical appraisal of quantitative research, Introduction to qualitative research, study designs and methods, analysing and interpreting qualitative data, critical appraisal of qualitative data; Mixed methods research, introduction to mixed methods research, study design and methods, analysing and interpreting of mixed methods data, critical appraisal of mixed methods research.

Introduction to Logic and Critical Thinking

Introduction to philosophy and logic, historical perspective to logic, Aristotelian logic, recent developments in logic, Modal logic, Fuzzy logic, critical thinking and validity of thought, basic logical concepts, proposition and sentence, Forms of augments, Augment and non – argument, deductive and validity, basic functions of language, conditional statements and implications, material equivalent and logical equivalence, Nature of inductive arguments

Mechanics

Physical units and dimensions; rectilinear motion with constant acceleration; displacement and velocity time graphs. Basic dynamic equations of motion: Newton's first, second, and third laws of motion; friction and its physical applications. Work and energy, work-energy theorem; law of conservation of linear momentum, impulse. Planar motion with constant acceleration; projectiles. Gravitational field and potential; law of universal gravitation. Introduction to satellite motion, Kepler's laws.

Thermal Physics

Temperature; thermal equilibrium; the zeroth law of thermodynamics; concepts of temperature, heat transfer processes: conduction, convection, radiation; calorimetry and specific heat capacity; latent heat and change of state; vapour pressures; quasi-static processes; work and heat; internal energy; general gas laws: Charles and Boyle's laws; introduction to kinetic theory.

Electricity and Magnetism I

Charge; Coulomb's law; electric field; electrostatic potential. Capacitors: energy of capacitors, capacitors in parallel and in series; electric current, magnetic fields; flux and flux density; magnetic flux density inside a long solenoid; electric current, magnetic fields; effect of a magnetic field on a moving charge; force on a current carrying conductor; force on a current carrying conductor; force between current carrying conductors; moving coil galvanometer; potentials and electromotive force; Kirchhoff's law; Ohm's law; resistance, resistivity and its temperature coefficient: potentiometer as a potential divider; basic principles of electromagnetic induction; transformers; cathode ray oscilloscope and its functions.

Optics

Geometrical Optics: Rectilinear propagation of light, shadows, eclipses. Reflection: diffuse and regular, laws of reflection images from plane and curved mirrors. Refraction: laws of refraction, Fermat's principle, refractive indices, real and apparent depth. Thin lenses: lens formula, lens aberrations. The prism and dispersion. Optical instruments: the eye, the microscope, the telescope.

Physical Optics: Introduction to waves: reflection, refraction and Huygens principle, principle of superposition of waves, interferometry and diffraction, diffraction gratings. Plane EM waves, EM spectrum, polarization by: reflection, refraction, transmission plates, ndichroism, and scattering. Introduction to optical activity.

Dynamics

Turning forces: couples, torque, static equilibrium, centre of gravity; rotational motion of rigid body about a fixed axis, moments of inertia. Conservation of angular momentum; rotational kinetic energy; equations of motion; Elastic and inelastic collisions; relative motion; inertial frames of reference; relative velocity; uniform relative translational motion; Galilean transformations; Fizeau and Michelson-Morley experiments, uniform rotating frames of reference; centrifugal, Coriolis forces.

Electricity and Magnetism II

Gauss' law and its application; capacitance and dielectrics; magnetic field and forces; circulating charges; electromagnetic induction; Lorentz force; torque on a current carrying coil; electric and magnetic moments; energy and dipole orientation; inductance, electromagnetic oscillations, resonance. Magnetic properties: paramagnetism, ferromagnetism and diamagnetism.

Oscillations and Waves

Periodic motion, simple harmonic motion: the basic equation, force and energy. Superposition of two harmonic motions, beats. Anharmonic oscillations. Damped oscillations. Forced oscillations, resonance. Concept of wave motion: standing waves, transverse and longitudinal waves, superposition of waves: phase and group velocity. Reflection and transmission of waves at an interface. Elastic waves in solids, rods, springs and air. Sound waves in a column of gas, sources of sound, Doppler effect. Acoustics.

Empirical Ideas of Quantum Physics and Relativity

The atomic nature of matter, electrons. Photons: black body radiation, photoelectric effect, Compton effect, X-rays. Atomic physics: atomic models, Rutherford's scattering experiment; optical spectra, Franck-Hertz, Bohr's atomic model, quantization of angular momentum, Stern-Gerlach, electron spin. Wave-particle duality: De Broglie's hypothesis, electron scattering (Davisson-Germer experiment), Bragg's condition. Relativistic physics: universality of the speed of light (electrodynamics, Michelson-Morley), the mass-energy equivalence. Nuclear Physics: simple nuclear models, the binding energy curve, fission and fusion, radioactive decay.

Thermodynamics

First law of thermodynamics; adiabatic work; equation of state of a gas; ideal gas; state diagrams, heat engines and the Carnot cycle; reversible and irreversible processes; the second law of thermodynamics; entropy, TS diagrams, reversibility and irreversibility; entropy and disorder. Thermodynamic potentials; free energy (Gibbs and Helmholtz); Maxwell thermodynamics relations; equilibrium between phases, Clausius-Clapeyron equation; Irreversible changes; the third law of thermodynamics.

Classical Mechanics

Newtonian Mechanics: Review of Newton's equations of motion; systems of particles; forces: gravitational, electro-magnetic, frictional, constraining, conservative; D'Alembert's principle. Variational calculus; Lagrangian formulation, constrained systems, symmetries and conserved quantities; application to rigid body motion. Hamiltonian formulation, symmetries and conserved quantities.

Relativistic Mechanics: Inertial frames, the principle of relativity, the postulates of Galilean space-time. The constancy of the speed of light, the postulates of special relativity, the Lorentz and Poincaré transformations. Lorentz contraction, time dilation, proper time, the twin paradox. Energy and momentum conservation, applications in particle physics, the relativistic equations of motion.

Introduction to Solid State Physics.

Review of the structure of matter; atomic and molecular energies; types of bonds; repulsive and attractive forces; amorphous and crystalline solids; crystal structures; symmetry and plane directions; defects and crystal disorder. Band theory: conductors, insulators and semiconductors; p-n junctions. Thermal, electrical and mechanical properties of solids.

Quantum Mechanics I (prerequisite SPH 206)

Review of wave-particle duality, the double slit experiment, probabilistic interpretation. The free particle: wave function, wave packets, Fourier transform, the Schrödinger equation. Particle in a potential (one-dimensional): time-dependent and time-independent Schrödinger equations, square well potentials, bound and scattering states, tunnelling, the harmonic oscillator. Linear operators, eigenvalues and eigenstates, expectation values, uncertainties, Heisenberg's uncertainty relation. The postulates of Quantum Mechanics.

Solid State Physics

Crystal formation; free electron theory; lattice vibrations; Review of Fermi-Dirac, Bose-Einstein and Maxwell-Boltzmann statistics; periodic potentials; phonons; Schrödinger equation; energy levels; degeneracy; density of states. Review of specific heat; Einstein and Debye theories of specific heat. Magnetic properties: ferromagnetism; paramagnetism; diamagnetism. Nuclear magnetic resonance; super-conductivity.

Electrodynamics

Vector and scalar fields: electric (E) and magnetic (B) fields from point charge, charge distributions, currents in wires and current densities. Maxwell's equations in their integral form; displacement current. Vector operations: Divergence and Curl, Stoke's and Gauss's theorems. Maxwell's equations in differential form. Electromagnetic waves in vacuum: Transverse EM waves, relation between E and B, polarisation, the speed of light. Poynting vector: energy and momentum transport in EM fields. The magnetic vector potential A, relationship to E and B, retarded potentials and causality with special relativity. The generation of EM waves/fields: the Hertzian dipole, aerials and atoms as sources of EM radiation.

Statistical Mechanics

Phase space; density of states; statistical distribution of systems of particles: microstates and macrostates; statistical weight; counting accessible states. The grand canonical ensemble; degrees of freedom in phase space, momentum-space and velocity-space; statistical thermodynamics: entropy, enthalpy and thermodynamic potentials; equilibrium of an isolated system; chemical potentials; equilibrium of a system in a heat bath: negative temperature. Probability distribution and partition function: Maxwell and Boltzmann, Bose-Einstein, Fermi-Dirac. Applications: paramagnetism, thermodynamics of black body radiation; Bose-Einstein condensation.

Quantum Mechanics II

Review of the postulates of quantum mechanics. Algebraic solution of the harmonic oscillator, the angular momentum algebra. Application: the hydrogen atom, electron spin, spin-orbit coupling. Perturbation theory: Riesz' variation principle, time-independent perturbation theory; the Schrödinger, Heisenberg and interaction pictures, time-dependent perturbation theory, application to optical transitions, selection rules. Many-particle systems: distinguishable and indistinguishable particles, bosons and fermions, the Helium atom or other applications.

Introduction to Special Needs Education

Meaning of Education; definition of education in various contexts, purposes of education; processes of education; how education takes place, education in traditional African setting, education and society, sociology of education; education and the institutions; the family, the government, the economy, religion and the school, school as a socializing agent; education and technology; education and citizenship.

Introduction to Computers

Historical background of computers; components of a computer system, basic computer organization, computer software, operating systems with hands on experience, hands on experience with a typical word processor.

Introduction to Spreadsheets and Databases

Database types, advantages and disadvantages, filled types creating and modifying fields in database; data entry and validation checks, importing and exporting tables; data handling, add, view edit, sort or filter data in a database creating using view files; SQL and query files; forms, creation, customizing, and printing of reports and mailing labels; designing and running of macros.

Information Systems Analysis and Design

Conducting feasibility studies, selecting the team, terms of reference; technical, cost sizing of equipment and manpower, operational feasibility, implication for people, organization, participative systems design, management of innovation, economic feasibility, cost benefit and capital investment analysis, estimation of cost, economics of information, valuation of benefits, the feasibility reports.

Web Design and Publishing

Internet and the world web (www); browsing and searching techniques, the internet as a research tool, search engines, introduction to hypertext markup language (HTTP); wed design, hosting and development, intranet concept; evolution, benefit and challenges.

Database Systems

Data base systems; data modeling and relational model; database quarry languages; relational database design; transaction processing; distributed database; physical database design.

Management Information Systems Introduction to management information systems hardware and software issues, application software packages, database management systems, ethical and security issues, systems analysis and design.

Internet Computing

History of evaluation of the internet, basic tools of internet access, emails, ftp, telnet, news, anarchies, www. Basic internet protocols, TCP/IP, SMTP, ftp, http, routers, algorithms and protocol for routing, internet programmesming, unix system calls, socket programmesming, languages for the internet, HTML, XML, Java scripts, perl, applications, network information discouvery and retrieval, web servers, robots and search engines, security issues, fire walls, encryption and protocols problems with internet, technical issues, future of the internet.

Multimedia Graphics

Fundamentals of design and visualization, creating illustrations, image creation, creating editing and optimizing graphics for commercial design; 2 Dimensional animation, 3D graphics multimedia authoring.

Electronic Commerce

E- commerce, benefits and shortcomings, business to business commerce, business to consumer commerce, building blocks of electronic commerce. Applications, internet and network protocols. Electronic payment systems. Security and transactions, review of cryptographic tools. Secure financial transactions. Payment transactions and standards, smart card and e- cash technologies. Anthentification, signatures, observers, anonymity, privacy, trace ability. Key certification, management and escrow, technologies for building e commerce, applications, distributed objects, object quest brokers and object oriented applications frameworks, some applications; supply chain management, internet auctions and remote banking.

Statistical Analysis with SPSS

Introduction; file manage; file systems, creating new files, opening saved files , saving files, printing, editing; cut and paste, editing options: Data manipulations: variable definition, inserting variables, inserting cases, variable transformation; statistics: summarize, custom tables, compairing means, general linear model, correlations and regressions, data reduction, reliability analysis, non-parametric tests. Graphics, bar charts, line graphs, pie chart, box plots, error bars, scatter plots, histograms, p-p plots, and time series.

IT and Society

History of computing, social context of computing, methods and tools of analysis, professional and ethical responsibilities, the electronic community, the changing nature of technological risks and liabilities of safety – critical systems, intellectual property, privacy and civil liberties, pornography and censorship, social implications of internet, computer crime, economic issues in computing, philosophical foundation of ethics.

Internet Controls and Security issues

Controls on data and information; input controls, processing controls, output controls; internal security, protection against fraud; computer crimes, computer viruses; security measures; information systems audit.

Human Computer Interactions (HCI)

The principles of HCI, modeling user interaction, window management system design, help systems, evaluation techniques, computer supported collaborative supported work.

Social and Professional issues in computing

History of computing, social context of computing, methods and tools of analysis, professional and ethical responsibilities, risks and liabilities of safety; critical systems, intellectual property, privacy and civil liberties, social implications of the internet, computer crime, economic issues in computing, philosophical foundations of ethics.

2. Content in Physics Teacher Education Programmes Common in Public Universities

General Methods of Teaching
Educational Media and Resources
Curriculum Development
Special Methods of Teaching
Educational Technology
Instructional Technology and Media Practices
Teaching Practice
Introduction to Psychology
Human Growth and Development
Human Behaviour, Guidance & Counselling
Tests and Measurements
Philosophy of Education
History of Education
Sociology & Comparative Education of Education
Environmental Education
Educational Administration Theories and Institutional Operations
Planning and Economics of Education
Entrepreneurship
Mechanics
Thermal Physics
Electricity and Magnetism I

Optics
Dynamics
Electricity and Magnetism II
Oscillations and Waves
Empirical Ideas of Quantum Physics and Relativity
Thermodynamics
Classical Mechanics
Introduction to Solid State Physics
Quantum Mechanics I (prerequisite SPH 206)
Solid State Physics
Electrodynamics
Statistical Mechanics
Quantum Mechanics II
Introduction to Special Needs Education
Introduction to Computers

3. Content in Physics Teacher Education Programmes Unique to Individual Universities

University A:

Communication Skills I
Communication Skills II
Quantitative Skills

University B:

Communication Skills I
Communication Skills II
Quantitative Skills
State, Society and Development

University C:

Research Methodology
Introduction to Logic and Critical Thinking
HIV and Aids Prevention and Management

University D:

Project work on teaching practice

University E:

Communication Skills I
Communication Skills II
Quantitative Skills
State, Society and Development

University F:

Introduction to Spread sheets and Databases
Information Systems Analysis and Design
Web Design and Publishing
Database Systems
Management Information Systems
Internet Computing
Multimedia Graphics
Electronic Commerce
Statistical Analysis with SPSS
IT and Society
Internet Controls and Security issues
Human Computer Interactions (HCI)
Social and Professional issues in computing

APPENDIX G: TEACHING STANDARDS ON THE TPAD FORM

2.1. EVALUATION CRITERIA AND RATING

This rating shall be used to establish the extent to which the teacher has met the targets set in each of the Performance Competency Areas and final annual performance.

Rating Grade	Rating Indicator	Rating Scale	Annual Rating Score
Very Good	Fully met and exceeded the targets	5	81% - 100%
Good	Fully met the targets	4	61% - 80%
Average	Met most of the targets	3	41% - 60%
Below Average	Met some of the targets	2	21% - 40%
Inadequate	Did not meet the targets	1	0% - 20%

2.2. TEACHING STANDARDS

	Performance Competency Areas	Performance Indicators	Performance Targets	Teaching/Learning Outcomes	Rating Scale (1-5) for each Target								
					Appraisee Rating			Appraiser Rating			Agreed Rating		
					Term 1	Term 2	Term 3	Term 1	Term 2	Term 3	Term 1	Term 2	Term 3
1	**Professional knowledge and Application** (25 marks, maximum 5 Targets)												
	Ability to prepare; Schemes of work, lesson plans and lesson notes based on current curriculum and syllabi, records of work, Teaching/learning aids, assess learners and provide feedback	**Availability and use of:** • Approved schemes of work, lesson plans, lesson notes, records of work, text books teaching/learning aids. • Test/examinations, marking scheme, learners marked exercise book/marked test papers and learners progress records; mark sheet	i. Undertake individual lesson observation at least once a term. ii. Prepare; schemes of work for approval by the 1st day of the term, lesson plans, notes and teaching aids based on current curriculum and syllabi before the beginning of each lesson. iii. Evaluate learners on masterly of content covered in line with the school testing policy and maintain updated records of work covered, and student progress records.	▪ Performance Index – enhanced knowledge in subject area. ▪ Improved scores in tests and examinations. ▪ Ability to recall learnt content. ▪ Ability to apply knowledge learnt in solving practical problems. ▪ Effective Syllabus coverage									

TSC/PCPA/TPAD/01/REV.1

	Performance Competency Areas	Performance Indicators	Performance Targets	Teaching/Learning Outcomes	Rating Scale (1-5) for each Target								
					Appraisee Rating			Appraiser Rating			Agreed Rating		
					Term 1	Term 2	Term 3	Term 1	Term 2	Term 3	Term 1	Term 2	Term 3
	and prepare and maintain learners' progress records. Individualized Education Program	• Individualized education programs. • Timely syllabus coverage. • Lesson observation rating	iv. Organize individualized learning programs to cater for all learners' needs. v. Cover the syllabus within the stipulated time and maintain updated records of work covered.										
2	**Time Management** (10 marks, maximum 2 Targets)												
	Ability to manage teaching time through consistent class attendance, observance of the school time table, attendance of other school activities and staff meetings	• Punctuality in reporting to duty and lesson attendance • Records of teacher presence, lesson taught/ missed, lesson recovered records, records of remedial lessons, staff meeting attendance. ▪ Timely preparation of professional records	i. Maintain punctuality in reporting for duty and lesson attendance, meet deadlines on preparation of professional records and participation in all other school programmes. ii. Ensure all lessons are taught as per the school timetable, exams set and marked and feedback given as per the deadline.	▪ Increased contact hours. ▪ Learners improved time management skills. ▪ improved learners' performance ▪ improved attendance of school activities by learners ▪ acquisition of wide knowledge									
3	**Innovation and creativity in teaching** (10 marks, maximum 2 Targets)												

	Ability to improvise and use locally available resources for effective teaching and learning outcomes	**Evidence of use of;** ▪ teacher prepared teaching/learning aids, ▪ ICT to access Online Educational Resources, ▪ ICT integration in teaching and learning in order to improve knowledge content and curriculum delivery.	i. Prepare and use appropriate teaching and learning aids and integrate ICT in teaching/learning. ii. Access and use appropriate ICT learning/teaching materials to improve knowledge and stimulate learning.	▪ Improved learners' knowledge in ICT. ▪ Active learner participation. ▪ learners ability to; develop their own learning materials, ▪ Enhance learners' creativity in apply ICT in their learning. ▪ Enhance creative thinking. ▪ Development of new concepts.									

TSC/PCPA/TPAD/01/REV.1

	Performance Competency Areas	Performance Indicators	Performance Targets	Teaching/Learning Outcomes	Rating Scale (1-5) for each Target								
					Appraisee Rating			Appraiser Rating			Agreed Rating		
					Term 1	Term 2	Term 3	Term 1	Term 2	Term 3	Term 1	Term 2	Term 3
		▪ Use of any other relevant approach.											
4	**Learner protection, safety, discipline and teacher conduct** (20 marks, maximum 4 Targets)												
	Knowledge of matters related to sexual, mental/ psychological, physical harassment/ abuse and the appropriate solutions. Adherence to legal and professional provisions.	▪ Evidence of compliance with CORT, COCE, and Children's Act and other statutory regulations regarding Children's Rights. ▪ use of teaching/learning aids that support learners safety and promote self-awareness ▪ create child friendly learning environment ▪ Sensitization programmes. ▪ Records of learners discipline cases and interventions. Evidence of parental involvement in learner's discipline.	i. Demonstrate understanding of legal provisions in education and the implication of non-compliance. ii. Ensure the learning environment is child friendly, safe and conducive by promoting self-awareness through sensitization and use of appropriate teaching /learning aids. iii. To maintain updated records of learner discipline cases, challenging behavior and interventions. iv. Maintain updated records of parental involvement in management of learner behaviour.	▪ Improved learners performance, ▪ Improved learner attendance. ▪ High retention rate. ▪ improved professional teacher/learner relationships ▪ Decreased learner discipline cases.									
5	**Promotion of Co-curricular activities** (10 marks, maximum 2 Targets)												

TSC/PCPA/TPAD/01/REV.1

	Performance Competency Areas	Performance Indicators	Performance Targets	Teaching/Learning Outcomes	Rating Scale (1-5) for each Target: Appraisee Rating, Term 1	Appraisee Rating, Term 2	Appraisee Rating, Term 3	Appraiser Rating, Term 1	Appraiser Rating, Term 2	Appraiser Rating, Term 3	Agreed Rating, Term 1	Agreed Rating, Term 2	Agreed Rating, Term 3
	Ability to organize and guide cocurricular and life skills learning activities to realize and nurture unique talents and develop them to their full potential	▪ Approved co-curricular schedules, membership lists, ▪ certificate of participation at different levels, ▪ evidence of awards, officiating, coaching, and training in co-curricular activities	i. Identify and nurture learners' talents in at least one co-curriculum activity. ii. Maintain up-to-date records on learner's participation in cocurricular activities including certificates, trophies and awards.	▪ Learners' participation in co-curricular activities. ▪ Individual talents identified and developed. ▪ Physical fitness and enhance learners' health.									
6	**Professional Development** (15 marks, maximum 3 Targets)												
	Identify individual performance gaps, training needs and seek solutions through professional development courses.	▪ Appraisal records. ▪ Enrollment for teacher professional development courses. ▪ Certificates for courses attended. ▪ Evidence of involvement in peer learning at school, zonal and or cluster levels. ▪ Involvement in subject panels in different levels. ▪ Participation in training and marking of exams at different levels.	i. Engage in termly appraisal process and be evaluated. ii. Be involved in Teacher Professional Development activities at school level and/or enroll in recognized/relevant professional courses. iii. Engage in peer learning at zonal, cluster levels and interact with educational specialist and networking with educational bodies e.g. KNEC, KICD, MOEST, etc.	▪ Extent of improved learner performance. ▪ Improved level in curriculum delivery. ▪ Effective learner assessment. ▪ Evidence of remedial action.									

7	Collaboration with parents/guardians and stakeholders (10 marks, maximum 2 Targets)												
	Establish and maintain collaborative relationships with	▪ Records of parental involvement.	i. Plan and participant in teachers, parents and learners meetings.	▪ Improved learner exposure and performance.									

	Performance Competency Areas	Performance Indicators	Performance Targets	Teaching/Learning Outcomes	Rating Scale (1-5) for each Target								
					Appraisee Rating			Appraiser Rating			Agreed Rating		
					Term 1	Term 2	Term 3	Term 1	Term 2	Term 3	Term 1	Term 2	Term 3
	educationalists, parents/guardians, and the local communities.	▪ Evidence of involvement in community development based activities. ▪ Records of involvement in exchange programmes and national initiative eg tree planting, advocating against FGM, etc. ▪ Evidence of involvement and networking with educational bodies e.g KNEC, KICD, MOEST etc	ii. Organize education community based activities that involve learners. iii. Develop linkages and participate in programmes organized in conjunction with other educational bodies.	▪ Learner ability to recognize individual abilities, limitations and values. ▪ Holistic learners (all rounded individuals).									
				TOTAL									
	ANNUAL SCORE (AVERAGE OF AGREED SCORE FOR TERM 1,2 & 3)												

APPENDIX H: TEACHER DEVELOPMENT IN SAMPLED TPAD FORMS

PART 3.0: TEACHER DEVELOPMENT

3.1. Teacher Support and Professional Development Planning Review of progress of the term and generate a teacher support and development plan to be implemented the following term

Performance Gaps	Recommended Support/Development Activities	Achievements	Remarks
Term 1: i. ICT integrations in learning ii. Subject masterly iii. Teaching methods iv. Inadequate knowledge of legal and professional documents governing education v. Identification of talent vi. Interpersonal skills vii. Inadequate skills in planning and time management viii. Inadequate skills in innovation and to creativity	i. Mentorship programme ii. Induction programme iii. Coaching programme iv. Peer support/team teaching v. School based professional development courses, seminars and workshops vi. Subject symposiums vii. Professional support by field officers and other educationists	Good mastery of Subject Content. - ICT Intergration is challenging. we utilize team teaching	- Need for ICT training - Need for workshops on methods of teaching Physics

Page 13 of 15

PART 3.0: TEACHER DEVELOPMENT

3.1. Teacher Support and Professional Development Planning Review of progress of the term and generate a teacher support and development plan to be implemented the following term

Performance Gaps	Recommended Support/Development Activities	Achievements	Remarks
Term 1: i. ICT integrations in learning ii. Subject masterly iii. Teaching methods iv. Inadequate knowledge of legal and professional documents governing education v. Identification of talent vi. Interpersonal skills vii. Inadequate skills in planning and time management viii. Inadequate skills in innovation and to creativity	i. Mentorship programme ii. Induction programme iii. Coaching programme iv. Peer support/team teaching v. School based professional development courses, seminars and workshops vi. Subject symposiums vii. Professional support by field officers and other educationists	Good Subject Mastery, interpersonal Skills and good time management	Little time available for creativity. No text books to guide improvisation

APPENDIX I: PARTICIPANTS' LETTERS OF CONSENT

Student Teachers' Letter of Consent

I am a post-graduate student at Maseno University, and carrying out research that aims to review physics teacher education as offered by the public universities in Kenya. This is to make the programmes more relevant to teaching of physics in secondary schools. I am interested in your views on various aspects of the teacher education programmes and in secondary school physics instruction that you are currently undertaking. Your responses will be kept confidential and used only for the purpose of this study. My request is that you spend a few minutes of your time to respond to the issues.

If you accept to fill in the questionnaire, please sign in the space provided below.

Signature ______________________________ Date ______________________________

Secondary School Head Teachers' Letter of Consent

Your school has been selected to participate in a research on "Evaluation of Physics Teacher Education Programmes as Offered by Public Universities in Kenya." Physics student teachers, Heads of physics subject and your self are requested to participate in order to assist in completion of the study. If you approve of your school's participation, I will thereafter proceed to contact the respective teachers for their involvement. If you have got any questions or in need of any clarifications, please you are free to ask. All responses made will be used purely for purposes of this research and kept confidential. If you accept to fill in the questionnaire and consent to the participation of physics student teachers and heads of physics subject, please sign in the space provided below.

Signature _________________________________ Date _______________________________

Name of the School ____

Heads of Physics Subject Letter of Consent

You are requested to participate in a research aimed at evaluating of physics teacher education programmes as offered by public universities in Kenya. This questionnaire is designed to collect information about physics instruction as is conducted by the physics teacher on teaching practice. The information you provide will be used purely for the evaluation of the physics teacher education and all the responses you provide will be kept confidential.

If you accept to fill in the questionnaire, please sign in the space provided below.

Signature ________________________________ Date _____________________________

Physics Teacher trainers' Letter of Consent

I am a post graduate student at Maseno University, and carrying out research that aims to evaluate physics teacher education as offered by public universities. I am interested in your views on four aspects of the teacher education namely objectives, content, methods of teaching and assessment strategies. Your responses will be kept confidential and used only for the purpose of the study. My request is that you spend a few minutes of your time to respond to the issues.

If you accept to fill in the questionnaire, please sign in the space provided below.

Signature ________________________________ Date _______________________________

Name of the University____

APPENDIX J: LETTER OF ETHICAL APPROVAL

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: 5th January, 2017

TO: Stellah Mutiembu Mukekhe
PG/PhD/0078/2012
Department of Educational Communication,
Technology and Curriculum Studies
School of Education, Maseno University
P.O Box Private Bag, Maseno, Kenya

REF:MSU/DRPI/MUERC/00350/16

RE: Evaluation of Physics Teacher Education in Relation to Pedagogical Needs of Student Teachers from Public Universities in Kenya. Proposal Reference Number: MSU/DRPI/MUERC/00350/16

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 5th day of January, 2017 for a period of one (1) year.

Please note that authorization to conduct this study will automatically expire on 4th January, 2018. If you plan to continue with the study beyond this date, please submit an application for continuation approval to the MUERC Secretariat by 5th December, 2017.

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 5th December, 2017.

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.

DIRECTORATE OF RESEARCH PUBLICATION & CONSULTANCIES 05 JAN 2017 MASENO UNIVERSITY

Yours faithfully,

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

Cc: Chairman,
Maseno University Ethics Review Committee.

MASENO UNIVERSITY IS ISO 9001:2008 CERTIFIED

APPENDIX K: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MISS. STELLAH MUTIEMBU MUKEKHE
of MASENO UNIVERSITY, 412-50409 NAMBALE,has been permitted to conduct research in *Bomet , Bungoma , Busia , Kakamega , Kericho , Kiambu , Kisii , Kisumu , Machakos , Makueni , Migori , Nairobi, Nakuru , Nandi , Nyamira , Nyeri , Siaya , Transnzoia , Uasin-Gishu , Vihiga Counties*

on the topic: *EVALUATION OF PHYSICS TEACHER EDUCATION IN RELATION TO PEDAGOGICAL NEEDS OF STUDENTS TEACHERS FROM PUBLIC UNIVERSITIES IN KENYA*

for the period ending:
21st November,2017

Permit No : NACOSTI/P/16/86743/14711
Date Of Issue : 21st November,2016
Fee Recieved :Ksh 2000

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit.
2. Government Officer will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one (1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEACH CLEARANCE PERMIT

Serial No.A 12000

CONDITIONS: see back page

APPENDIX L: LETTERS OF INSTITUTIONAL RESEARCH AUTHORISATION

1. National Commission for Science, Technology and Innovation

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email:dg@nacosti.go.ke
Website: www.nacosti.go.ke
when replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/16/86743/14711**

Date: **21st November, 2016**

Stellah Mutiembu Mukekhe
Maseno University
Private Bag
MASENO.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Evaluation of physics teacher education in relation to pedagogical needs of students teachers from public universities in Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **selected Counties** for the period ending **21st November, 2017.**

You are advised to report to **the Vice Chancellors of selected Universities, the County Commissioners and the County Directors of Education of the selected Counties** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. M. K. RUGUTT, PhD, HSC.
DIRECTOR-GENERAL/CEO

Copy to:

The Vice Chancellors
Selected Universities.

The County Commissioners
Selected Counties.

National Commission for Science, Technology and Innovation is ISO 9001:2008 Certified

2. University of Nairobi

UNIVERSITY OF NAIROBI
OFFICE OF THE DEPUTY VICE - CHANCELLOR
(Research, Production & Extension)
Prof. Lucy W. Irungu B.Sc., M.Sc., Ph.D.

P.O. Box 30197-GPO.
00100,Nairobi-Kenya
Telephone: +254-20-2315416 (DI), 318262

Fax:0202317251
Email:dvcrpe@uonbi.ac.ke

UON/RPE/3/5/XVII/

November 29, 2016

Stellah Mutiembu Mukekhe
C/o Maseno University
Private Bag
Maseno

AUTHORITY TO CONDUCT RESEARCH IN THE UNIVERSITY OF NAIROBI

Approval is hereby granted for you to collect data from the University of Nairobi for your research project entitled, "*Evaluation of physics teacher education in relation to pedagogical needs of student teachers from public universities in Kenya*", in partial fulfillment of the degree of Doctor of Philosophy in Pedagogy (Physics) at Maseno University.

Upon completion of your study, you are expected to share the findings of your study with the University of Nairobi by depositing a copy of your research findings/report with the Director, Library & Information Services.

LUCY W. IRUNGU
DEPUTY VICE-CHANCELLOR
(RESEARCH, PRODUCTION AND EXTENSION)
&
PROFESSOR OF ENTOMOLOGY

Copy to: Vice-Chancellor
Deputy Vice-Chancellor (AA)
Deputy Vice-Chancellor (A&F)
Deputy Vice-Chancellor (SA)
Director, Library and Information Services

SWM/...

ISO 9001:2008 CERTIFIED

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2. Masinde Muliro University of Science and Technology

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

Tel: 020 241 88 54
Fax: 056-31444
Email: research@mmust.ac.ke
Website: www.mmust.ac.ke

P. O. Box 190
Kakamega - 50100
Kenya

Directorate of Research & Extension

REF: MMU/COR: 403037

7th December, 2016

Stellah Mutiembu Mukekhe
Maseno University
Private Bag
MASENO

Dear Mukekhe

RE: <u>RESEARCH AUTHORISATION</u>

You have been authorized to collect data on your research on "***Evaluation of Physics Teacher Education in Relation to Pedagogical Needs of Students Teachers from Public Universities in Kenya***" The researcher is asked to observe ethical issues in the process of data collection. The respondents are therefore requested to cooperate so as to facilitate the research process to proceed smoothly.

Masinde Muliro University of Science and Technology would request the researcher for a copy of the findings of the research once it is complete.

Thank you.

Prof. Achoka, JSK
DIRECTOR, RESEARCH AND EXTENSION

Copy to:

- Deputy Vice Chancellor, Planning, Research & Innovation, MMUST

4. Kenyatta University

KENYATTA UNIVERSITY

OFFICE OF DEPUTY VICE-CHANCELLOR, RESEARCH, INNOVATION AND OUTREACH

P. O. Box 43844 - 00100
Nairobi. Kenya
Tel. 254-20-810901 Ext. 026
E-mail: dvc-rio@ku.ac.ke

Ref: KU/DVCR/RCR/VOL.3/12

Ms. Stellah Mukekhe,
Maseno University
Maseno

6th December, 2016

Dear Ms. Mukekhe,

RE: **REQUEST TO COLLECT RESEARCH DATA AT KENYATTA UNIVERSITY**

This is in reference to your letter dated 29th July, 2016 requesting for authorization to collect research data at Kenyatta University on the topic: *The* Evaluation of Physics Teacher Educationin Relation to the Pedagogical Needs of Student Teachers from Public Universities in Kenya towards a PhD degree of Maseno University.

I am happy to inform you that the Vice-Chancellor has approved your request to collect data. It has been noted that your data will be collected mainly from academic staff and students in the School of Education.

The University requires that, upon completion of your thesis/project, you submit a bound hard copy to the Deputy Vice-Chancellor, Research who shall forward it to the University Library. Kindly therefore complete Form RIO3 and return it to my office prior to the collection of data.

Yours Sincerely,

Prof. F. Q. Gravenir
Deputy Vice-Chancellor
Research, Innovation & Outreach
cc. Vice-Chancellor
Dean, School of Education

5. Egerton University

Stellah Mutiembu Mukekhe

Dept. of Educational Comm., Tech. and Curriculum Studies

Maseno University, Kenya

3rd March 2016.

DEPUTY VICE CHANCELLOR * RESEARCH & EXTENSION * EGERTON UNIVERSITY P.O. Box 536 - 20115 EGERTON

To the Deputy Vice Chancellor,

Research and Extension,

Egerton University.

Approved ensure confidentiality & feed back with us. 27/7/2017

RE: Request for Permission to Collect Data

I am a post graduate student from Maseno University and am currently collecting data towards my research Thesis titled

> *"Evaluation of Physics Teacher Education in Relation to the Pedagogical Needs of Student Teachers from Public Universities in Kenya"*

I request to be allowed to administer research tools to the trainers of physics teachers (lecturers) and physics teacher trainees in your institution.

Looking forward to your positive response.

Yours faithfully

Stellah Mutiembu Mukekhe

0721 267362

DEPUTY VICE CHANCELLOR EGERTON UNIVERSITY RECEIVED 27 JUL 2017 P.O. Box 536 - 20115 EGERTON RESEARCH & EXTENSION

6. Moi University

MOI UNIVERSITY

OFFICE OF THE DEPUTY VICE CHANCELLOR
ACADEMICS, RESEARCH AND EXTENSION

Tel: (053) 43355
(053) 43620
Fax: (053) 43412
Email: dvc_are@mu.ac.ke *or* dvcresearchmu@gmail.com

P.O. Box 3900
Eldoret - 30100
Kenya

REF: MU/DVC/REP/27B

9th November, 2016

TO WHOM IT MAY CONCERN

RE: PERMISSION TO COLLECT DATA –STELLAH MUTIEMBU MUKEKHE

Ms. Stellah M. Mukekhe who is a Ph.D. Student at Maseno University, Department of Educational Comm., Tech. and Curriculum Studies has applied for authority to collect data.

We would be grateful if she is permitted to collect her data on ***"Evaluation of Physics Teacher Education in Relation to the Pedagogical Needs of Student Teachers from Public Universities in Kenya."***

By a copy of this letter authority is hereby granted to her to collect the data.

After the completion of the research, a complete report both on hard and soft copy will be handed over to the office of Deputy Vice-Chancellor, Academics, Research & Extension.

Any assistance accorded to her will be highly appreciated.

Thank you.

Yours faithfully,

PROF. I. N. KIMENGI, Ph.D.
DEPUTY VICE-CHANCELLOR
(ACADEMICS, RESEARCH & EXTENSION)

SKM/sa

(ISO 9001: 2008 Certified Institution)