Evaluation of Content in Physics Teacher Education in Relation to Pedagogic Skills of Student Teachers in Public Universities in Kenya

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***Abstract:* - Public universities in Kenya have been training physics teachers using the adapted Bachelor of Education (B.Ed) Science programmes that have been passed over from the founding universities. Growing disparities in the key content areas of the training among the universities has been witnesses, and yet, secondary school instruction to be conducted by the teachers is common. Moreover, poor performance of 38.27% in physics has been recorded in Kenya Certificate of Secondary Education examinations (KCSE) in the last 10 years and blamed on the training of teachers at the universities. These raise questions on whether content in physics teacher education equips student teachers with the requisite pedagogic skills. This study employed descriptive survey research design and participants consisted of 420 physics student teachers, 277 heads of physics subjects and 130 physics teacher trainers. It was revealed that content in physics teacher education should be enhanced to address key areas in secondary school physics, employ a variety of teaching and assessment strategies and focus on equipping student teachers with 21st century skills. The findings may be useful to public universities in Kenya to align content in B.Ed (Science) in physics programmes to acquisition of pedagogic skills necessary for effective secondary school physics instruction.**

***Key Terms:* - Pedagogic skills, Public universities, students with learning disabilities**

I. INTRODUCTION

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 [29]. Similar sentiments had been made earlier by [9] 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 [19], it is also necessary that acquisition of pedagogic skills that include subject matter knowledge, assessment skills, communication skills, skills in use of resource materials and skills in use of information technology are addressed in physics teacher education programmes.

As [10] has argued, preparation for everyday instruction for a physics teacher should revolves around the understanding of the physics curriculum, 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. Reference [34] has also 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. Furthermore, range of optional courses should be offered which allow students to develop specialisation in subject disciplines.

It has further been noted by [10] that the programme design in teacher education should be able to allow key concepts to be revisited over the period of the course in order to develop deeper understanding. Also, cultural aspects of the citizens should be integrated in the implementation of teacher education. Similarly, [34] recommended that physics teacher education should embrace school placement programmes where communication and interpersonal skills of the student teachers are to be addressed. The placement programmes should provide opportunities for student teachers to integrate theory and practice, develop classroom organisation skills, behaviour management skills and use resource materials and Information Technology in physics instruction.

However, physics teacher education has been of concern in many countries. For instance, In the Philippines, deficiencies in physics content and low continuing professional involvement were established to be the major teacher related indicators that affect secondary school physics instruction [2]. While in Nigeria, it was revealed that many teachers emerge from training without functional understanding of some elementary but fundamental concepts in physics [7]. The problems experienced by secondary school physics students in Ojo state in Nigeria were blamed on the university undergraduate physics content that did little to equip the teachers with necessary knowledge and skills.

Similarly, majority of teachers in South Africa display limited content knowledge coupled with ineffective teaching approaches and unprofessional attitude [20]. Teachers in South Africa 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. Of concern also is that a study done by [30] 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.

In Kenya, performance in Kenya Certificate of Secondary Education (KCSE) physics examinations between the years 2008 to 2017 is 36.43% which is represented by a letter grade D. This performance is below an average of 50 out of 100 hence poor. Moreover, a survey carried out by [32] 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. While [14] blames the poor performance on poor pedagogy in secondary school physics instruction, which do little to provide the needed interventions that can enable secondary school physics students realise their potential.

In a presentation to the Education World Forum on curriculum reform in Kenya, [12] 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 poor performance in physics is therefore detrimental to an economy that is to be founded on physics knowledge acquired by its citizens as outlined in the Kenya Vision 2030 document.

A. Research Questions

The study sought to answer the following research questions:

1. What is the relevance of content in physics teacher education to acquisition of pedagogic skills?
2. To what extent are student teachers engaged in secondary school physics instruction in light of the requisite pedagogic skills?
3. What are the suggestions for improvement on content in physics teacher education for acquisition of pedagogic skills?

II. METHODS EMPLOYED IN THE STUDY

A. Research Design

The design of the study was a descriptive survey. Descriptive survey entails an investigation of issues as they affect an activity such as teacher education. Reference [4] 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.

B. 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 six public universities that participated in the study have been graduating over 90% of the physics teachers annually [18] and the graduates have thereafter been recruited to teach in secondary schools all over the country in the period of this research. This has been at the back drop of poor performance in secondary school physics witnessed in the last 10 years that calls for research intervention.

C. Participants

The study population comprised 420 physics student teachers who were undertaking teaching practice from 6 public universities in Kenya, 277 heads of physics subject in secondary schools where the student teachers were undertaking their teaching practice and 130 physics teacher trainers from public universities, specifically drawn from the departments of pedagogy and content. This enabled the researcher solicit the views of the experts needed in the current study. As [33] has proposed, 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.

D. Sample Size and Sampling Techniques

Purposive sampling was used in the study where the total population of 351 physics teachers, 225 heads of physics and 108 physics teacher trainers participated in the study. As [17] 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. 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, 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. Each category of the sample was approximately 84% of the population while the remaining 16% were used in the pilot study.

E. Research Instruments

The survey used Questionnaire for Physics Student Teachers, Questionnaire for Heads of Physics Subject, Questionnaire for Physics Teacher Trainers and Document Analysis Guide.

F. Validity of the Instruments

Face validity of the instruments used in this study was determined by scrutinizing each item and 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 relevance and scope in answering the research questions and in addressing all the aspects of the evaluation process.

G. *Reliability of the Instruments*

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 [16]. The respondents included 67 physics student teachers from one of the universities, 38 physics heads of departments in secondary schools where the student teachers undertook their teaching practice and 22 physics teacher trainers. 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 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 [33].

III. RESULTS, DISCUSSIONS AND CONCLUSION

A. *Results*

Table 1: Relevance of Content in Physics Teacher Education to Acquisition of Pedagogic Skills (Physics Student Teachers, n = 351)

No.	Content in Physics Teacher Education Programmes	Mean Score out of 5
1	Content on subject matter knowledge	3.32
2	Content on acquisition of assessment skills	4.17
3	Content on acquisition of communication skills	4.20
4	Content on acquisition of skills in use of resource materials	4.17
5	Content on acquisition of skills in use of information technology	2.83

Table 2: Engagement of Student Teachers in Secondary School Physics Instruction in Light of the requisite Pedagogic Skills (Heads of Physics Subject, *n* = 225)

Engagement of student teachers in Secondary School Physics Instruction	Mean Score out of 5
Subject matter content	3.03
Use of assessment strategies	2.94
Communication skills in physics instruction	2.56
Skills in use of resource material	2.91
Skills in use of information technology	2.41

Table 3: Suggestions for improvement of Content in Physics Teacher Education for Acquisition of Pedagogic Skills (Teacher Trainers, *n* =108)

Improvements on content of Physics Teacher Education	Frequency, *f* (%)
Need for training to address content in secondary physics	38(35.2)
Several assessment methods in secondary physics to be used	33(30.6)
Need to integrate IT in teaching of physics content	21(19.4)
Need to revamp practical work during training	16(14.8)

Qualitative data was also scrutinised and the following remark on existing gaps on content in physics teacher education in light of the pedagogic skills necessary for effective instruction by student teachers was noted

HoS 14"The TP teacher has difficulty in delivery in topics like Magnetism and measurement. The way he handles content in Form 2 physics is unsatisfactory as he has difficulties with applications"

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

Furthermore, document analysis of the Teachers Performance Appraisal and Development (TPAD) tool was found to emphasise the need for teachers to exhibit mastery of professional knowledge and application with a focus on the subject content. Scrutiny of completed TPAD forms revealed that 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, inadequate skills in management of the safety of students, children's rights, innovation and improvisation, and also, teachers' lack of creativity in physics instruction.

B. *Discussion*

The findings of the current research are similar to that of a research done by [3] who established that beginning physics teachers have limited content knowledge. Similarly, [35] have reported that subject content is an essential component of teacher education and 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. Reference [24] 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.

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 [31]. While [15] 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. Also, [19] has 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.

However, several authors have pointed out to the problematic nature of pre-service teachers' content knowledge [13]; [35] & [6]. 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 the teachers' preparation for the lessons and therefore, the need for teacher education to equip student teachers with adequate and relevant subject matter knowledge.

Moreover, helping students to learn the subject matter involves more than the delivery of facts and information. This is because the goal of education is to assist students develop intellectual abilities that enable students participate in the major domain of human thought and inquiry. And also, enable students to use intellectual ideas and skills as tools for gaining control over every day real world problems. Reference [6] 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 [35]. 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.

Suggestions by the physics teacher trainers gathered in the current study are in agreement with findings of a study conducted by [24] in Coconino County in Arizona, in which it was established that the participants requested for professional development in the area of assessment of academic standards of their learners. 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 [5]. On the other hand, formative assessment informs stakeholders on the extent of attainment of the learning objectives.

Reference [23] 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, [22] 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 training of physics teachers.

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 [23]. Similarly, [31] 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 physics teacher education should therefore, equip student teachers with the requisite communication skills for effective instruction.

Moreover, [31] has noted that effective communication is key for teachers' delivery of content, classroom management and interaction within the classroom, while [11] has argued that 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. Reference [34] has reaffirmed that content in physics teacher education should comprise professional studies that involve courses in subject pedagogies, subject disciplines and courses in secondary school placement. 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 [28].

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 [26]. While [25] 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 [34] 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, [33] 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. Further, one such way as to get students to connect actively is through effective use of resources by improvisation.

These sentiments are also shared with [1] who argues that as good as improvisation is in the 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. Similarly, [27] have recommended that physics teachers should be able to improvise produce and use both material and ideas to aid instruction at all times. Therefore, content in teacher education should endeavour to equip the student teachers with knowledge and skills in the use of resource materials and improvisation.

As revealed by the current study, integration of information technology in teaching physics is necessary foe effective instruction. However, [24] has asserted that few teachers have been taught how to teach their subject matter with technology and yet, the way teachers learned their subject matter is not necessarily the way students should be taught. Such sentiments were also made by [21] that 20% of public school teachers in USA felt uncomfortable with the use of information technology in teaching. Similarly, recent efforts in curriculum reforms in Kenya have experienced challenges such as lack of capacity for teachers to implement a competency-based curriculum [14]. This was more so in the area of use of information technology in teaching hence the need for physics teacher education to link the use of information technology in delivery of physics content. As [36] has observed, Information Technology (IT) enables users to produce and share content effectively, and in support of these views, [21] has argued that IT and 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.

On the other hand, [34] 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. Reference [21] 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 also, what it means to teach with technology. In support of these views, [10] asserts that integration of technology in all courses in the teacher preparation should be considered. This is in order to be more supportive of the technology-enhanced pedagogical content knowledge and content specific applications. Technology therefore needs to be integrated in delivery of content in physics education if secondary school physics instruction is to benefit from a similar model.

C. Conclusions

Content in physics teacher education programmes should address key areas in secondary school physics, employ a variety of teaching and assessment strategies with a focus on use of resource materials and information technology. Key areas that should be addressed by physics teacher education also include: approaches to effective classroom control and management of students, 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.

D. Implications

Findings of the current study would enable public universities in Kenya to enhance content in physics teacher education to enable student teachers acquire the requisite pedagogic skills, necessary for effective secondary school physics instruction.

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