

Research Article

## The Biology Content Knowledge and Skills Exhibited by Pre-Service Biology Teachers in Kenyan Universities

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**Abstract:** This study was instigated by the urgent need for sufficient content knowledge and skills of teaching secondary school biology in Kenya, whose lack thereof has occasioned consistent poor performance by students in national examinations for the last 9 years. The study was implemented using the descriptive survey research design and was conducted in selected universities across the Republic of Kenya and public secondary schools in Bungoma County, Kenya. The target populations were 4000 fourth year undergraduate Biology education students on their teaching practice, who were all selected from Kenyan public universities that offer Bachelor of Education Science degree program. A sample of 400 undergraduate students was selected from 3 universities and used as respondents by simple random sampling technique. Data were collected using observation checklists. A pilot study was carried out two weeks to the actual study, to assess the suitability of these research instruments for collecting the required data before the actual study. Validity of the instruments was assessed using the Rasch Model, while reliability of the quantitative ones was assessed using the test-retest method. The collected data were analyzed using descriptive measures namely; frequencies, means and percentages. Results revealed that the sampled pre-service Biology teachers' content knowledge and skills needed to teach Biology in Kenyan secondary schools was average hence insufficient for effective implementation of the Biology curriculum.

**Keywords:** Content, Knowledge, Skills, Pre-Service

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## BACKGROUND OF THE STUDY

A critical analysis of the trend in students' academic performance in biology at secondary school level over the last nine years shows a lackluster and discouraging scenario. In 2003, for example, the mean score was 25.54 and 15.56 for papers 1 and 2 respectively. The following years were no different, with the mean scores of 37.77 and 17.31 in 2004, then 28.22 and 13.38 in 2005 for the papers 1 and 2 respectively. The introduction of paper 3 did little to salvage the situation, performance still remained generally dismal, with an overall mean score of 34.89 in 2006 and 40.64 in 2008. It is clear that there has been a consistent poor performance in all the biology papers with lower mean scores in all the three biology papers. The poor performance has been attributed to ill preparation of Biology teachers in Content Knowledge and Skills (CKS) required for effective transfer of Biology concepts to students in Kenyan secondary schools (KNEC, 2017).

In Kenya, CKS that are mandatory and required for effective Biology Teacher Education (BTE) are imparted into Pre-Service Teachers (PST) by universities that offer Bachelor of Education Science (B.E.D) degree program at undergraduate level. While training therefore, pre-service teachers of Biology in Kenyan universities are prepared to deliver Biology Content Knowledge (BCK) itself, Biology Pedagogical Skills (BPS) i.e. the approaches, techniques, methods and practices for teaching and learning Biology (Mwangi, 2016). Furthermore, they are also prepared on how to use technology to ameliorate the teaching and learning complex and abstract aspects of the Biology syllabus, for successful attainment of our national goals of education with respect to Biology, which is one of the compulsory subjects in most Kenyan secondary schools (MoE, 2015).

In most societies, both in and outside Kenya, it is believed that good quality education will translate to an informed population and hence good running of systems in all sectors of the economy, hence good standards of living at the end of it (World Bank, 1998).

Kenyan universities are therefore on their part, expected to ensure that all pre-service teachers who pass through their system are effectively prepared by equipping them with sufficient and appropriate CKS, to ensure this demand from key stakeholders in the Kenyan society is met. The current poor performance by students in biology therefore leaves a lot to be desired, which call for research on the status of knowledge and skills imparted to prospective teachers in Kenyan universities. The objective of this study was to ascertain the biology content knowledge and skills exhibited by pre-service Biology teachers in Kenyan universities. The research question formulated from this objectives was.

*“Which content knowledge and skills are exhibited by pre-service Biology teachers?”*

## LITERATURE REVIEW

Stronge, (2002) stated that content knowledge is a teacher’s knowledge of the subject matter that is to be taught. Clearly, preparation of a teacher’s subject matter knowledge positively influences students’ performance; however, it is not sufficient in itself. Teacher education programs that prepare pre-service teachers emphasize content knowledge acquisition and neglect other important areas like pedagogical coursework hence are less effective in preparing prospective teachers to teach students in program that offer both content and pedagogical knowledge (Shulman, 1987). According to Boyd, (2007) the “No Child Left Behind” legislation aims to change the landscape by requiring states to ensure that all teachers are adequately prepared.

The legislation considers new teachers to be highly qualified if they receive state certification and demonstrate content knowledge of the material they teach, either by passing the subject-area examination or by having undergraduate major in that subject, or both (Boyd, 2007). Studies of middle and high school teachers, primarily mathematics and science, reveal that coursework in both pedagogy and content areas have positive impact on student achievement (Stronge, 2002; Boyd, 2007). With respect to grade level, the evidence indicates that, while preparation in terms of pedagogical coursework seems to rely on teachers’ effectiveness at all grade levels, the importance of coursework in content area are most apparent in secondary level. Ferguson and Womack (1993) assessed the extent to which preparation of teachers in subject matter coursework could predict the performance of student teachers completing a university teacher education program. In this study, teaching performance was measured by 107 survey items that assessed 13 categories of teacher expertise.

Ferguson (1993) found that the proportion of variance in teacher performance explained by their preparation in terms of amount of education coursework

taken was 16.5 per cent. In contrast, measures of content explain less than 4 per cent. These results suggested that education coursework is a more powerful predictor of teaching effectiveness and student achievement than measures of content expertise as indicated by grade point average and NTE specialty scores. Monk and King (1994), in a later study, drew on more refined measures of teacher coursework to examine the impact of various types of teacher preparation on student achievement mathematics and sciences. The reviewed literature studies were done in the US and majored on students’ achievement. The present study investigated the preparation of teachers of Biology, with focus on TPCKS.

Teachers are expected to be well prepared to engage every child in class by challenging learners while ensuring the participation of all children (Ferrini, 2001). Research done by the National Council of Education and Training (National Commission on Teaching and America’s Future, 2004) established that children learn to enjoy science- an important premise- since science can be used and enjoyed in the long life. It was further established that children learn important and meaningful science concepts through that understanding. NCTM conducted its study on primary school pupils, the present study was conducted among teacher trainees and their trainers in Kenyan universities.

According to National Council for Teacher Education (2009), inadequate teacher preparation in mathematics that includes the teacher’s own understanding and the nature of mathematics inside pedagogical challenges deprives students of motivation and appreciation values which are critical in secondary and higher level institutions in the said higher learning institutions. In these said higher learning institutions, some teachers are reported to adopt the traditional text book centered approach that drills the teacher’s own mathematics teaching. Research done to establish meta-analysis outcomes for students with learning disabilities (Davis, 2000) identified some effective instructional approaches in mathematics that combine both systematic and strategic instruction. They include sequence of instructional skills through breaking down tasks, prompting or providing cue and processing demands of tasks through sequencing from easy to difficult. These if used in Biology could lead to more effective delivery of Biology concepts from the teacher to the learner.

Preparation of teachers in terms of a well-designed instructional routine is equally important, through presentation of subject matter, modeling where the teacher provides demonstration of process or steps to solve problems or explain how to do a task, drill repetition and practice review through testing (Davis, 2000). When teachers of mathematics for instance,

engage in the above systematic process of preparation and teaching, it is very easy for learners to process the input. The above literature was in mathematics instruction; the present study has investigated biology education in light of classroom practice.

Adedeji, (2008) asserted that teacher preparation programs are key sources for their content knowledge of student-centered instructions, general pedagogical knowledge including classroom routines and pedagogical content knowledge. They further established that teacher preparation program provide novice teachers with framework by which to organize, understand and reflect on their experience in the classroom. Teacher preparations therefore include a service of course on child development instructional and assessment techniques and methods and materials related to specific content areas (Stronge, 2002). This study sought to investigate to what extent the knowledge of teaching amongst teachers influences their acquisition of pedagogical skills.

Studies of pre-service Biology teacher education programs reveal mixed evidence regarding the degree to which these programs contribute to teacher's content knowledge. These studies offer limited evidence with regards to contribution of teacher education program to teacher competencies or student achievement (Rice, 2003). Pigge, (1978) basing on questionnaire responses from 1,851 principals and 770 teachers across grade levels, found out that teachers perceive that competencies most necessary to do their work were those learned on the job. Clark (1985) used observation, interview and survey data from 44 first year teachers and two student teachers from a number of different teacher education programs. The study found that the most frequently perceived origin of ideas for teaching practices were teachers own ideas. Clark's study was done in the USA while this study will be done in Bungoma County, Kenya. Clark's study did not include the lecturers who teach university students pedagogical skills.

Levine, (2006) asserted that there is conflicting and competing beliefs globally on "issues as basic as when and where teachers should be educated, who should educate them and whether content knowledge is most effective in preparing teachers. This observation, combined with the traditional belief (that teachers tend to teach as they themselves were taught) and the ad hoc approach it tends to be done in teacher striving to meet the most common teaching challenges like preparing students to perform satisfactorily on national exams) most likely explains the unsatisfactory status of in-service teacher education in most developing countries (Info Dev, 2010). This study intended to establish new strategies that are learner centered to help the teacher acquire meaningful knowledge skills and attitudes in biology education.

Novak, (2000) posits that learners seek to acquire new content knowledge and propositions to relevant existing concepts and propositions in their cognitive structures. He further argues that the desired teacher encourages learners to "construct progressively more powerful explanation, wrestle with and resolve inconsistent and unnecessary complexities in their thinking and evaluate and challenge the knowledge and value claims of others". In terms familiar to process educations, this means that a desired teacher is an educator committed to using the practices of effective teaching within the classroom (Burke, 2007). These practices are outcome process, students centered and indeed built on research that indicates that people learn best when they construct their own understanding based on their own previous knowledge, skills experiences and beliefs (Hanson, 2007). Such a teacher helps learners improve their learning skills, like those in the affective domain, such that students achieve a positive attitude towards learning a sense of self efficiency, the ability to manage frustration and willingness to take risks in learning (Duncan, 2009). These teachers strive to, continuously, improve students' learning outcomes such that learners move from the level of mere information and memorization through conceptual understanding to application, problem solving and then, possibly to the highest level: that of the researcher who has "innovative expertise which can be used to develop new understanding and problem solutions" (Bruke, 2007). While these studies considered general learners, the present study investigated biology teachers' education while at university.

Traditional teacher preparation program provide individuals with methodology courses that allow prospective teachers to learn pedagogical content/ knowledge necessary for quality instructions (Darling, 2009). Lackzko, (2002) suggests that teachers need extensive training in order to develop a deeper knowledge of subject matter and ability to teach this subject matter to diverse student population. In addition, training and course work provided in most traditional teacher preparation programs is necessary for promoting student achievement (Darling & Hammond, 2006). However, extensive teacher training in a 4 year program does not guarantee an effective teacher and only a small percentage of what affects students learning and academic achievement is associated with teacher experience and degree (Wilson, 2002).

In a study to examine the differences in teaching practices between those educated through alternative preparation programs and those educated through alternative preparation programs with aforementioned components, 41 alternatively trained teachers were matched with 41 traditionally trained teachers. The findings based on interviews with the teacher's classroom observations, student's scores on the Iowa test of basic skills and three additional

mathematics assessments, showed that there appeared to be no effect of type of teacher training on student achievement. The study conducted in Iowa compared the two sets of teachers used: Ex post facto experimental design and achievement test for students. This study was conducted in Kenya using survey research design, questionnaires for teachers and student teachers were also included in the study.

SMASE, (1998) recommended that teachers approach in methodology ought to change and that they should find time for preparation and research in order to impact on student achievement. In his study about the relationship between some teacher variables and students achievement in mathematics, Okonkwo, (2000) found that the qualification and experience of the teacher had a serious effect on the performance of junior secondary one student. The literature dwells mostly on mathematics and secondary school students' achievements. This study focused on biology student teacher preparation at undergraduate level and how to improve teachers' classroom practices.

A study by Cimer, (2011) on what makes biology learning difficult and effective students view in Turkey revealed that the main reason for learning difficulties were the nature of the topic, teachers' style of teaching, students learning and studying habits, students negative attitude towards the subject and lack of resources. A self-administered questionnaire including three open ended questions was employed to collect data. It was administered to 207, 11<sup>th</sup> grade students in Rise District. The data was analyzed both qualitatively and quantitatively. This study differs with Cimer's because it was done in Kenya, interview schedule, observation guide and questionnaire, were used to collect data which was analyzed qualitatively and quantitatively. The respondents were lecturers, students and graduate teachers.

Teachers are the main link between society's expectations and their education system and concerted student outcome. In Latin America, the link is weak and the quality of teachers and teaching leave much to be desired (UNESCO, 2007). In a study in Latin America trained teachers were found to often quickly revert to old habits and teaching methods. INSET attended was found to have little effect on their ability to use the innovation and good practices they were exposed to during the training (Handerson, 2007). The Dakar conference of 2000 was concerned with quality education and emphasized education for all by 2015 since the United Nations had declared education a human right (Njiru, 2012). If education for all was to be achieved by 2015 in Sub-Sahara Africa an additional 4 million teachers were required. The present study intended to establish best practices for biology teachers in the classroom, so as to enhance achievement of EFA,

MDG's and attainment of Kenya vision 2030 as explained in the Kenya constitution of 2010.

Okpala and Onacha, (1990) posit that experienced integrated science teachers resort to innovation in their classes more than their counterparts still undergoing teacher training. Mac Donald and Regan (1988) in studies in South Africa observed positive changes in teacher behavior and student performance during Science Education Project (SEP) in Ciskei, Transkei, Soweto and Durban. They used science teaching observation schedule to observe classroom practices of SEP teachers and demonstrated that they learnt more classroom practices than their counter parts from Canada and United Kingdom. However, students' performance in examinations improved though it was still poor (Okpala and Onacha, 1990).

The domain of learning environment research has produced many promising findings leading to enhancement of teaching and learning process in many countries. Research on learning environments has dominated Western and Asian countries (Ozkal, Tekkaya and Cakiroglu, 2009) with most of the studies focusing on the students' perception of the learning environment. For example, the studies have focused on the relationship between the perception of learning environment and attitude; Perception of learning environment and motivation (Wei and Elias, 2011; Okurut-Opolot, 2010). However, studies on the perception of the constructivist learning environment from the teacher's perspective are few in the global scene and specifically in Kenya. Therefore, there is need to do more studies on perceptions of the constructivist learning environment which has been associated with positive cognitive gains particularly from the perspective of teachers in Kenya where teaching is transmissionist in nature. Teachers being pillars of effective instruction thus need adequate preparation in TPCK and hence the need for the current study.

Borghi's, (2001) research in biology education has shown a growing interest in studying the teacher's ideas and how it plays a crucial role in Italy where major changes in the initiated teacher education are being implemented. A consistent effort is devoted to improving in service teacher preparation. Teacher appraisal has eventually become a normal part of life in school. Despite conflict over the best way to do this, it is generally accepted that the observation of the teaching process will play a key role (Agatha, 2009).

Obiero, (1994) argues that teachers should be thought of as professionals holding certain useful perspective which should be taken into account in evaluation of effectiveness involving students in a classroom achievement. Agatha, (2009) holds the same

view that teacher's perspectives should be gathered for effective INSET provision and evaluation. A study to evaluate biology teacher's attitude towards INSET in Philippines revealed that there was an increase in teacher's knowledge of biology and process of science after the program. In addition, it was found that the students performed better in achievement tests (Villavicebcio, 2003). This study differs from these studies because it looks at how to improve pre-service biology teachers' preparation in classroom practices.

A similar study by Agatha, (2009) on provision of in-service training of mathematics and science teachers in Botswana revealed some failures on the side of INSET program. The data was collected from sample of 42 senior mathematics and science teachers using structured interviews and open-ended questionnaires that were analyzed quantitatively. This study differs with Agatha's because it has been done in Kenya and results were analyzed both qualitatively and quantitatively.

A study on the effect of INSET program in mathematics and science on classroom interactions carried out by Sifuna and Kaine, (2007) focused on four districts, a case study of primary and secondary schools in Kenya. It included holding interviews with 185 teachers, observing lessons and organizing focus group discussions with students. It was established that while teachers reported the INSET program to have been effective in exposing them to student centered approach, this was however, not reflected in their practices that were largely teacher centered.

Obiero (1994) suggests two theories with regards to perspective; espoused theory and the theory in use. Espoused theory is one which gives allegiance to and is given when a person is asked how they would behave under certain circumstances. Theory in use is the one which governs a person's action. Although most people do not behave congruently with their espoused theories; they do behave congruently with their theories in use but are unaware of this fact. Therefore, by using multiple data collection techniques, the researcher shall be able to get the respondents' perspectives. This study, therefore, improves on validity by using questionnaires, interview schedule and classroom observation as data collection instruments. Integrating interviews with classroom observations shall be useful in distinguishing beliefs from mere romancing or convictions from random answers (Obiero, 1994).

Studies with secondary school science teachers are scarce compared to studies carried out with elementary teachers. Appleton, (1995) found that elementary teachers gained more confidence when they experienced success in learning science content and also when they experienced how the subject is taught after undergoing a science method course. This

highlights the importance of developing PCK. Harlen and Holroyd, (1997) state that "confidence in a specific area of content is closely related to knowledge of that content". However, confidence is also influenced by other factors such as school and personal experiences, the nature of initial and in service experience, pressure of curriculum overload, support from colleagues and material resources and the teachers own view of professional capability (Harlen and Holroyd, 1997). This last factor refers to the teachers' perceived self-efficacy.

The theoretical framework of self-efficacy is embedded in social cognitive theory. Self-efficacy beliefs have two dimensions. They indicate the level of self-confidence in a teacher's own teaching abilities, known as personal science teaching self-efficacy (PSTE). They also reflect the belief that students learning can be influenced by effective teaching, which is known as the science teaching outcome expectancy belief (Bandura, 1997). The present study intends to establish efficiency of preparation of biology teachers. The study mainly used constructivist theoretical framework in teaching and learning of biology.

## **MATERIALS AND METHODS**

The study was conducted in several universities across the republic of Kenya and partly in various secondary schools in the Bungoma County, Kenya. This study area was preferred because it is endowed with many academic institutions, including universities that offer BTE and secondary schools, all of which offer Biology as a compulsory subject.

Data for this study were collected using a mixed method approach, in which both qualitative and quantitative approaches were employed.

The study was interested in undergraduate students taking BTE who were 4000 in number. From these, 400 B. Ed science undergraduate students were selected from 3 public universities that offer B. Ed Science program. Simple random sampling was used to select the respondents.

Data were collected using the Pre-service Teachers Observation Checklist (PTOC), where, the researcher observed pre-service teachers' classroom practices teachers as they conducted their TP and recorded the data in the PTOC. Specifically, the researcher looked out for lesson plans, schemes of work prepared by the student-teachers and how they were using them to implement the curriculum.

To assess the suitability of research instrument for capturing the required data accurately, a pilot study was carried out two weeks to the actual study, in one Kenyan public university and one secondary school in Bungoma County, whereby 4 pre-service Biology

teachers on their teaching practice were used. These institutions and participants were excluded from the actual study, so as to prevent halo effect and pre-conceived findings during the actual study.

The researcher assessed content validity of the research instrument by seeking assistance from two supervisors and one expert on the topic of the study. The research instrument used in this study was also assessed for reliability before the actual study, using data from the pilot study via the test retest method of reliability analysis. To facilitate analysis, raw data were coded in SPSS version 23, and analyzed descriptively to generate frequencies and percentages.

## RESULTS AND DISCUSSION

The objective of this study was to ascertain biology content knowledge and skills exhibited by pre-service Biology teachers. The first Research Question (RQ) was formulated from this objective thus:

*RQ: What biology content knowledge and skills are exhibited by pre-service Biology teachers?*

To address this research question, the research assistants were asked to observe the various indicators of biology content knowledge and skills then filled the Pre-Service Teachers' Observation Checklist (PTOC). The first indicator that was investigated using this PTOC was teacher's preparation in terms of preparation and availing of schemes of work and lesson plan. In the SOW, the researcher looked at whether it was available, drafted in line with the syllabus and appropriate remarks made after a week of content delivery.

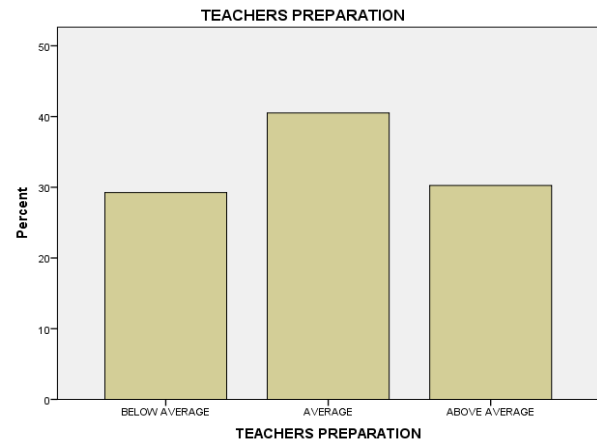
In the lesson plan, the researcher looked at whether the objectives were correctly stated, learning activities stated and sequential arrangement of content in concurrence with the schemes of work and the syllabus. A teacher whose score on this item was 0 to 4 marks was classified as below average in terms of preparation to teach while the one who scored between 5 and 6 marks was classified as average in terms of preparation for instruction. The teacher who scored between 7 and 10 was classified as above average in terms of preparation. All responses to this indicator were analyzed using frequency counts and percentages and the results were as displayed in Table 1 thus:

**Table 1:** Pre-Service Teachers' Preparation Rating

Preparation Rating	Frequency	Percent
Below Average	117	29.3
Average	162	40.5
Above Average	121	30.3
Total	400	100.0

As it can be observed from the Table, 117 pre-service teachers' preparation was found to be below average, a figure that translates to 29.3% of the sample size. The Table further informs us that 162 pre-service

teachers' preparation was found to be average, a figure that translates to 40.5% of the sample size. Moreover, the Table reveals that 121 pre-service teachers' preparation, which translates to 30.3% of the sampled respondents, was classified as above average. The same findings were presented on a bar graph to give them a pictorial outlook thus:



**Figure 1:** Percentages of Teachers' Preparation Rating

It can be deduced from the Table 1 and Figure 1 that majority of sampled respondents was classified average in terms of preparation to teach Biology in secondary school.

The second indicator of Biology Content Knowledge and Skills in the PTOC was lesson presentation. Under this indicator, the researcher assessed the quality of the lesson introduction, lesson development e.g. logical presentation of content, adequacy of content, use of appropriate teaching methods for that content, mastery of the content, use of verbal and non-verbal communication, selection and appropriate use of instructional resources, classroom organization and management, then conclusion of the lesson.

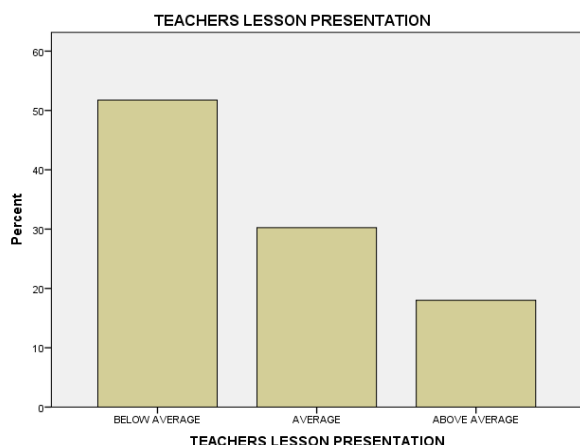
Each of these items was scored on a scale of 1 to 10 and classified as; below average, average or above average just like the previous indicator. Responses to all items under this indicator were analyzed using frequency counts and percentages and the results were as displayed in Table 2 thus:

**Table 2:** Pre-Service Teachers Lesson Presentation Rating

Lesson Presentation Rating	Frequency	Percent
Below Average	207	51.8
Average	121	30.3
Above Average	72	18.0
Total	400	100.0

As it can be observed from the Table, 207 pre-service teachers' lesson presentation was found to be

below average, a figure that translates to 51.8% of the sample size. The Table further informs us that 121 pre-service teachers' lesson presentation was found to be average, a figure that translates to 30.3% of the sample size. Moreover, the Table reveals that 72 pre-service teachers' lesson presentation, which translates to 18.0% of the sampled respondents, was classified as above average. The same findings were presented on a bar graph to give them a pictorial outlook thus:



**Figure 2:** Percentages of Teachers' Lesson Presentation Rating

It can be deduced from the Table 2 and Figure 2 that majority of sampled pre-service teachers was rated below average in terms of lesson presentation.

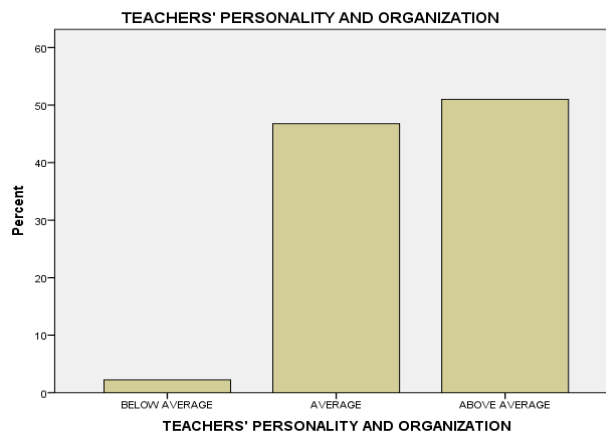
The third indicator of Biology content knowledge and skills measured by the PTOC was teachers' personality and organization. Under this indicator, the researcher assessed the teachers' dress code, confidence while interacting with learners in class, maintenance of professional records and handling of questions from learners. Each of these items was scored on a scale of 1 to 10 and classified as; below average, average or above average just like the previous indicators. Responses to all items under this indicator were analyzed using frequency counts and percentages and the results were as displayed in Table 3 thus:

**Table 3:** Pre-Service Teachers Personality & Organization Rating

Lesson Presentation Rating	Frequency	Percent
Below Average	9	2.3
Average	187	46.8
Above Average	204	51.0
Total	400	100.0

Table 3 clearly points out that 9 pre-service teachers' personality and organization were found to be below average, a figure that translates to a paltry 2.3% of the sampled pre-service teachers. The Table also indicates that 187 pre-service teachers' personality and organization were found to be average, a figure that

translates to 46.8% of the sample size. Additionally, the Table points out that 204 pre-service teachers' personality and organization, which translates to 51.0% of the sample size, was classified as above average. The same findings were presented on a bar graph to give them a pictorial outlook thus:



**Figure 3:** Teachers' Personality and Organization Rating

It can be deduced from the Table 3 and Figure 3 that majority of sampled pre-service teachers were rated above average in terms of their personality and organization.

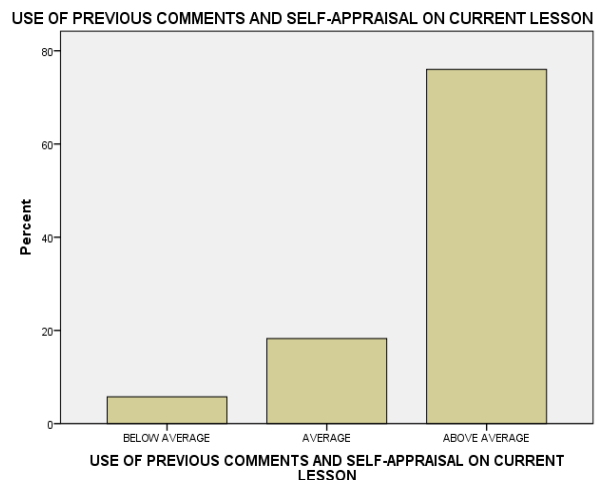
The fourth and last indicator that was measured by the PTOC was teachers' use of previous comments and self-appraisal on the current lesson. Under this indicator, the researcher assessed how the pre-service teachers were using the comments made in their earlier lessons as documented in the lesson plans and SOW to improve the achievement of instructional objectives during the subsequent lesson. Each of these items was scored on a scale of 1 to 3 and classified as; below average =1, average=2 and above average=3. Data concerning this indicator were analyzed using frequency counts and percentages and the results were as displayed in Table 4 thus:

**Table 4:** Pre-Service Teachers' Improvement of Subsequent Lessons

Improvement Rating	Frequency	Percent
Below Average	23	5.8
Average	73	18.3
Above Average	304	76.0
Total	400	100.0

Table clearly points out that only 23 pre-service teachers' were rated below average in terms of their use of previous comments and self-appraisal to improve their current lesson. This figure translates to a paltry 5.8% of the sampled pre-service teachers. The Table also indicates that 73 pre-service teachers' were rated average on the same indicator, a figure that translates to 18.3% of the sampled pre-service teachers.

Additionally, the Table points out that a whopping 304 pre-service teachers, which translates to 76.0% of the sample size, were rated above average in terms of their use of previous comments and self-appraisal to improve their current lesson. The same findings were presented on a bar graph to give them a pictorial outlook thus:



**Figure 4:** Teachers' Personality and Organization Rating

It can be deduced from the Table 4 and Figure 4 that majority of sampled pre-service teachers was rated above average in terms of how well their used previous comments and self-appraisal to improve their subsequent lessons.

The research question as outlined in chapter one of this document was, "which content knowledge and skills are exhibited by pre-service Biology teachers?" The findings with respect to the this research question, following a descriptive analysis of all items in the PTOC revealed that; majority of sampled pre-service teachers were rated average in terms of preparation to teach Biology in secondary school, below average in terms of lesson presentation, above average in terms of their personality and organization and above average in terms of how well they used previous comments and self-appraisal to improve their subsequent lessons. All these indicators put together, it can be concluded from the data collected by the PTOC that majority of the sampled pre-service teachers were average in terms of Biology content knowledge and skills needed to teach Biology in Kenyan secondary schools. These findings are in agreement to those of Maina, (2018), whose study was carried out on 234 pre-service teachers carrying out their teaching practice in Nyeri county secondary schools revealed that Biology pre-service teachers did not have sufficient Biology content knowledge and skills as was observed during their teaching practice.

The findings are also in harmony with those of Mdawida, (2017), whose case study was carried out on 18 pre-service teachers from a local Kenyan university

while carrying out their teaching practice in secondary schools in Kwale County. His case study revealed that in Biology pre-service teachers, 65% were classified as average in terms of Biology content knowledge and skills that they exhibited while on teaching practice.

The findings of this study are however in contrast to those of Omwoyo, (2016), whose mixed methods research that was carried out on 56 pre-service teachers from one local Kenyan university while carrying out their teaching practice in secondary schools in Kisii County indicated that of all the Biology pre-service teachers used 43 of them, which translated to 77% of the sample size were classified as below average in terms of Biology content knowledge and skills that they exhibited while on their first teaching practice. It is noteworthy, however, that the respondents were only in their second year of study and therefore did not have sufficient biology content knowledge. Omwoyo, (2016) noted that the same respondents scored significantly higher scores in Biology content knowledge and skills when they went for their second teaching practice in their fourth year of study.

## CONCLUSION

On the basis of empirical evidence arising from data that were collected by this study's research instrument and the subsequent statistical data analyses, the conclusion arrived at is that the Biology content knowledge and skills taught in Kenyan universities with respect to the B.E.D Science degree program is insufficient for their effective delivery of biology content at secondary school level, all as a result of failure to cope with advancement in technology.

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