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Research Article

The Biology Teachers' Training Needs and Competencies in the Use of Technology for Biology Instruction in Kenyan Secondary Schools

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Abstract: The study investigated the biology teachers' training needs and competencies in the use of technology for instruction in Biology in Kenyan secondary schools. The research was based on David Ausubel's Meaningful Learning Theory and was implemented via a mixed methods approach, using descriptive survey research design as a model. The target population was the 400 fourth year undergraduate Biology education students in the 25 public universities that offer Biology teacher education programmes and 200 of their biology teacher education lecturers. The study's sample comprised of 400 undergraduate students and 20 lecturers, all selected from 3 public universities in the country. The respondents were selected by purposive, proportionate stratified and simple random sampling. Data were collected using the Teachers' Technological Training Needs' Questionnaire (TTTNQ), which was validated at the piloting stage two weeks to the actual study, using biology instruction research experts. Reliability of the TTTNQ was also verified during the pilot study, using the test-retest method. The collected data were analyzed quantitatively, using frequencies and percentages whose findings have been presented in form of tables, bar graphs and pie charts. Results revealed that majority of the selected pre-service teachers have numerous technological training needs for effective biology instruction, a revelation that has implications that may affect future policies on the Biology teacher training programmes offered in Kenyan public universities currently.

Keywords: Training Needs, Competencies, Skills, Pre-Service, Technology

BACKGROUND OF THE STUDY

Trends in students' academic performance in biology at secondary school level over the last nine years shows a a steady decline (KNEC, 2017). In 2003, for instance, 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 and13.38 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 technological Skills needed for effective implementation of the Biology curriculum.

In America and many other parts of the developed world, technology taught at different stages of the learners educational cycle has been used to effectively teach biology and other science subjects effectively, leading to high students' achievement in the subject. However in Kenya, technological skills 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. The prospective biology teachers are prepared at this point on how to use technology to ameliorate the teaching and learning if various concepts in the Biology curriculum (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 biology teaching technology, to ensure this demand from key stakeholders in the Kenyan society is met. The current poor performance by

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students in biology therefore leaves a lot to be desired, which call for research on the status of technological skills imparted to prospective Biology teachers in Kenyan public universities. The objective of this study was therefore to establish the biology teachers' training needs and competencies in the use of technology for instruction in Biology. The research question formulated from this objectives was

> *"What are the biology teachers' training needs and competencies in the use of technology for instruction in Biology?"*

LITERATURE REVIEW

Today, several technologies are present throughout the world for example the use of computers, e-learning materials, videos among others. Teachers must therefore change their way of teaching based on several kinds of technological devices. To enable students to get by in all areas where they need ICT, it is necessary to prepare them well on how to use these technological tools. It is important to attract the interest of students from multiple sources of reliable and organized use of technology to be able to express their creativity (Harlen and Holroyd, 1997).

Today, many believe that technology improves considerably and that is why, pre-service teachers need to know the mode of operation thereof. This reality challenges us more, because teachers modify their learning in relation to preparation to use educational technology. A computer allows students to have access to more comprehensive sources of information. They learn basic skills related to information retrieval (Ronald, 2011). In class, the teacher and the manual are not the only sources of information because several choices are available to them. Moreover, the integration of ICT in the classroom can allow us, as future teachers, to instruct students and to socialize more with respect to websites.

There are many advantages of integrating Information Communication Technology in the learning process. It is essential to make good use in our classes, because the technologies are the next generation. Moreover, the use of ICT has had many impacts on students' performance. According to Ronald, (2011) technology improves the motivation and the pleasure of learning from some things they know well. In addition, information technology and communication can exploit the websites that are accessible to all. Students enjoy learning from what interests them and that's why they come to better understand what is explained by the teacher. Access to sources of information helps the learner to realize their potential for learning and creating. This is an advantage of technology integration in classrooms (Ronald, 2011).

ICTs can help to develop skills to work in collaboration and data processing. Access to sources of information allows learners to develop Meta cognitive skills the learner needs to advance their technological tools. Using these skills, the teacher establishes technological activities that help them work better on the computer. According to Ronald, (2011), ICT promotes increased student achievement because this tool allows them to progress at their pace and needs. With the help of access to sources of information, learners are also able to update their learning potential and creativity.

Terry, (2011) explains the various advantages of ICT in learning that; where information and communications technology (ICT) is taught well, it has been shown to enhance pupils' levels of understanding and attainment in other subjects. That's because real ICT is more about thinking skills than about mastering particular software applications. ICT can provide both the resources and the pedagogical framework for enabling pupils to become effective independent learners. For example, computer programs are available that adjust themselves to the pupils' level and then set appropriate tasks and give feedback on performance. Also, newer technologies such as Web 2.0 applications enables pupils and others to collaborate in ways that reflect a broadly constructivist approach to education. ICT places all learners on an equal footing (Terry, 2011). Given the right hardware, software and curriculum activities, even severely physically disadvantaged pupils can achieve the same degree of success as anyone else.

ICT has been shown to have benefits in terms of motivating pupils. That comes about partly through factors like being able to produce nice-looking work with no teacher's red marks all over it, and partly because the computer is seen as being impartial and non-judgmental in its feedback to the pupil. ICT enables pupils to gather data that would otherwise be difficult or even impossible to obtain and gather data that would otherwise be time-consuming or costly or both. For example, pupils can use the internet to get up-to-the-minute information on prices. They can use a DVD or the internet to watch movies of old dictators speaking, or the moon landings, or to listen to a piece of music by Mozart.

ICT enables pupils to experiment with changing aspects of a model, which may be difficult or even impossible for them to do otherwise. For example, pupils of Business Studies and Economics can see what might happen to the economy if interest rates were raised or lowered. Educational technology puts the pupil in control (if it is well-designed), enabling her to personalize the interface, select and create resources, and even choose what to teach (Terry, 2011). Schnotz and Bannert, (2003) explain that the use of computer presentations has the features of both audio and visual presentations that are being used in the

teaching/learning process for effective dissemination of knowledge; it involves the program or instruction to be delivered which are recorded in a video tape or disc. This method applies to both the sight and hearing senses of the learner thereby fostering the retentive memory and recalling ability of the learners.

Computer technique is able to use information from figurative point of view by using an imagery presentation rather than a symbolic description of facts to build internal representation of phenomenon (Schnotz and Bannert, 2003). ICT integration involves use of animation teaching which could be in form of lesson presentation, in that, still pictures; text, graphics, motion picture, background sound as well as some narrations are synchronized or combined at the same time in order to enhance learner's understanding of concepts. It also includes the use of interactive elements such as graphics, text, video, sound and cartoon teaching (Kellerman, 2004).

Student learning "from" computers is what Korbak and Whaley, (2001) described as discrete educational software (DES) programs, such as integrated learning systems (ILS), computer-assisted instruction (CAI), and computer-based instruction (CBI). These software applications are also among the most widely available applications of educational technology in schools today, along with word-processing software, and have existed in classrooms for more than 20 years (Becker, Ravitz, & Wong, 1999). Information and communication technologies (ICTs) are a "diverse set of tools and resources used to communicate, create, disseminate, store, and manage information." These technologies include computers, the Internet, broadcasting technologies (radio and television), and telephony.

Mayer, (2005) has provided evidence that students learn more effectively when words and pictures are combined ("multimedia effect") than from words alone and when printed words are placed adjacent to corresponding pictures ("spatial contiguity effect"). These results are consistent with the cognitive load theory, which is based on the concept that there is a limited amount of working memory, and by using both visual and auditory channels, working memory is increased (Mayer *et al.,* 2001). Cox and Abbot (2004) found out that there is extensive evidence of ICT contributing to improve learning by learners by helping them develop better reasoning strategies and relate their learning in a wider context.

Boster *et al.,* (2002) examined the integration of standards-based video clips into lessons developed by classroom teachers and found out that it increased student achievement. The study of more than 1,400 elementary and middle school students in three Virginia school districts showed an average increase in learning for students exposed to the video clip application compared to students who received traditional instruction alone. Teachers may use power point presentations to supplement instruction and introduce topics. The program also manifests two key assumptions about how computers can assist learning. First, the user's ability to interact with the program is designed specifically to promote learning with the tools. Second, computers are viewed as a medium for learning, rather than as tools that could support further learning (Murphy *et al.,* 2001). In a review of existing evidence of computer technology's impact on learning, Marshall (2002) found strong evidence that educational technology "complements what a great teacher does naturally," extending their reach and broadening their students' experience beyond the classroom.

A study done by Korfiatis *et al*., (1999) on investigation of the effectiveness of computer simulation programs as tutorial tools for teaching population ecology at university found out that computer simulations improved the comprehension of ecological processes expressed in mathematical form, but they do not allow a full understanding of ecological concepts. Thus, a balanced teaching procedure, involving both simulation programs and textbook-based lectures, is considered more appropriate for the teaching of ecological theory.

Tella (2012) did a study on an assessment of secondary school teachers' use of ICT'S: implications for further development of ICT'S use in Nigerian secondary schools and he found out that teachers generally have access to ICTs in their various schools except e-mail and Internet because their schools are not connected. Technical support are lacking in the schools and teachers lack of expertise in using ICT was indicated as being the prominent factors hindering teachers readiness and confidence of using ICTs during lesson. Furthermore, the results show that teachers perceived ICT as being easier and very useful in teaching and learning.

Research has shown that a large number of students' performances are affected by their attitude towards specific subjects, education and academics in general (Bowen and Richman, 2000). Major findings of Wasanga, (1997) on the attitude between primary and secondary school in Kenya revealed that students have moderately positive attitudes towards science. The factors identified to have an influence on the attitude of learners included; the opinion that science is difficult and poor teaching approaches where teachers did not necessarily explain concepts to students.

Sivin-Kachala and Bialo (2000) reviewed 311 research studies on the effectiveness of technology on student achievement. Their findings revealed positive and consistent patterns when students were engaged in

technology-rich environments, including significant gains and achievement in all subject areas, increased achievement in preschool through high school for both regular and special needs students, and improved attitudes toward learning and increased self-esteem. These researchers focused on the general attitude of students on achievement and not in the specific area of integrating ICT in learning cell biology and their effect on students' attitude.

College students are increasingly using technology not only to communicate with friends and family, but also as an integral part of their course work. Laird and Kuh (2005) surveyed over 60,000 college freshman and seniors to better understand the relationship between information technology and student engagement. They found positive relationships between academic uses of technology and student engagement in three particular areas; academic challenge, student-faculty interaction, and collaborative learning. While technology can be misused, when integrated appropriately by a skilled instructor, information technology can have a profound effect on student engagement, motivation, and achievement. From this positive change in students' achievement it necessitates the study to check on the influence of integrating ICT in learning cell biology in secondary schools in Nandi south sub county, Kenya.

MATERIALS AND METHODS

The study was conducted in several universities across the republic of Kenya and partly in various secondary schools in western 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 Teachers' Technological Training Needs Questionnaire (TTTNQ), which was administered to fourth year pre-service teachers on Teaching Practice in various secondary schools in western Kenya.

To assess the validity and reliability of the TTTNQ, 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 therein 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. Pilot results showed that the instrument was suitable for data capture. To facilitate analysis, raw data from the TTTNQ were coded in SPSS version 23, and analyzed descriptively to generate frequencies and percentages.

RESULTS AND DISCUSSION

The objective of this study was to establish the biology teachers' training needs and competencies in the use of technology for instruction in Biology. The Research Question (RQ) was formulated from this objective thus:

RQ: What are the biology teachers' training needs and competencies in the use of technology for instruction in Biology?

To address this research question, the Teachers' Technological Training Needs Questionnaire (TTTNQ) was administered to all the sampled pre-service teachers while on their teaching practice. All responses to items in the TTTNQ were analyzed by computing frequency counts and percentages. To this end, one of the statements in the TTTNQ sought to find out the competencies of the sampled respondents on the use of PowerPoint to teach biology. Responses to this question item were as presented in Table 1 thus:

Table 1: I know how to Use PowerPoint to Teach Biology

Response	Frequency	Percent
Strongly Disagree	10	2.5
Disagree	40	10.0
Not Sure	20	5.0
Agree	180	45.0
Strongly Agree	150	37.5
Total	400	100.0

It can be seen from the Table that 10 of the sampled pre-service teachers, which translates to 2.5% of the sample size strongly disagreed with the statement while 40 of them, which translates to 10% of the sample size disagreed with the statement. The Table further shows that 20 pre-service teachers, which translates to 5% of the sample size were not sure while a whopping 180 of them, which translates to 45% of the sample size agreed with the statement. Additionally, the Table shows that 150 pre-service teachers, which translates to 37.5 of the sample size strongly agreed that they knew how to make PowerPoint slides to teach Biology. The same findings were presented on a pie-chart to give a more pictorial outlook thus:

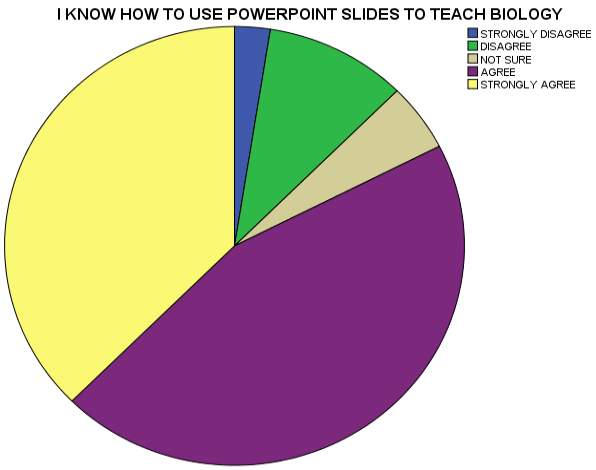

Figure 1: I know how to Use PowerPoint Slides to Teach Biology

It is apparent from Table 1 and Figure 1 that majority of the respondents affirmed to knowing how to make PowerPoint slides to teach Biology, which is an indicator of high competent technological skills for Biology instruction.

Another indicator of technological competency in this study was the ability to set up and use an LCD projector. One statement in the TTTNQ was designed to collect data to this effect and the results were as presented in Table 2 thus:

Table 2: I can Set Up and Use an LCD Projector by Myself

Response	Frequency	Percent
Strongly Disagree	11	2.8
Disagree	36	9.0
Not Sure	13	3.3
Agree	154	38.5
Strongly Agree	186	46.5
Total	400	100.0

It can be seen from the Table that 11 of the sampled pre-service teachers, which translates to 2.8% of the sample size strongly disagreed with the statement while 36 of them, which translates to 9% of the sample size disagreed with the statement. The Table further shows that 13 of the pre-service teachers, which translates to 3.3% of the sample size were not sure, while 154 of them, which translates to 38.5% of the sample size agreed with the statement. Additionally, the Table shows that 186 pre-service teachers, which translates to 46.5% of the sample size strongly agreed that they could set up and use an LCD projector by themselves. The same findings were presented on a pie-chart to give a more pictorial outlook thus:

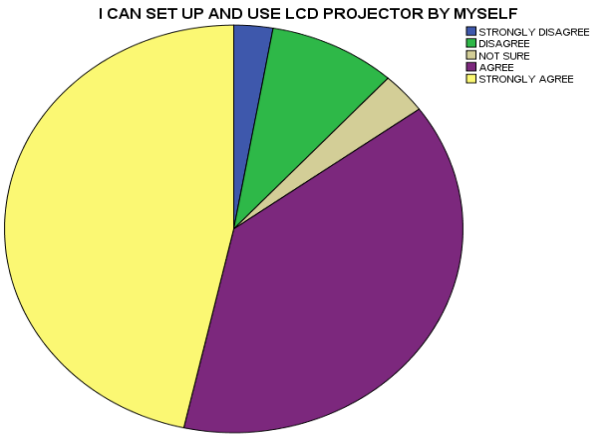

Figure 2: I can Use Up and Use an LCD Projector by Myself

It is can be deduced from Table 2 and Figure 2 that majority of the respondents positively affirmed their ability to set up and use an LCD projector, which is another good indicator of high competency in terms of technological skills required for Biology instruction.

Another indicator of technological competency in Biology instruction in this study was the ability to type fast using MS Word. One of the statements in the TTTNQ was designed to collect data to this effect and the results were as presented in Table 3 thus:

Table 3: I'd like to Use Computer to teach Biology but I'm Slow at Typing

Response	Frequency	Percent
Strongly Disagree	118	29.5
Disagree	229	57.3
Not Sure	33	8.3
Agree	20	5.0
Strongly Agree	118	29.5
Total	400	100.0

The Table reveals that 118 of the sampled pre-service teachers, which translates to 29.5% of the sample size strongly disagreed with the statement suggesting that they were slow at typing hence unable to use computers for Biology instruction while 229 of them, which translates to 57.3% of the sample size disagreed with this statement. The Table further illustrates that 33 of the pre-service teachers, which translates to 8.3% of the sample size were not sure, only 20 of them, which translates to 5% of the sample size agreed with the statement. Furthermore, the Table shows that 118 of the selected pre-service teachers, which translates to 29.5% of the sample size strongly agreed that they were slow at typing hence could not use computers for Biology Instruction. The same findings were presented on a pie-chart to give a more pictorial outlook thus:

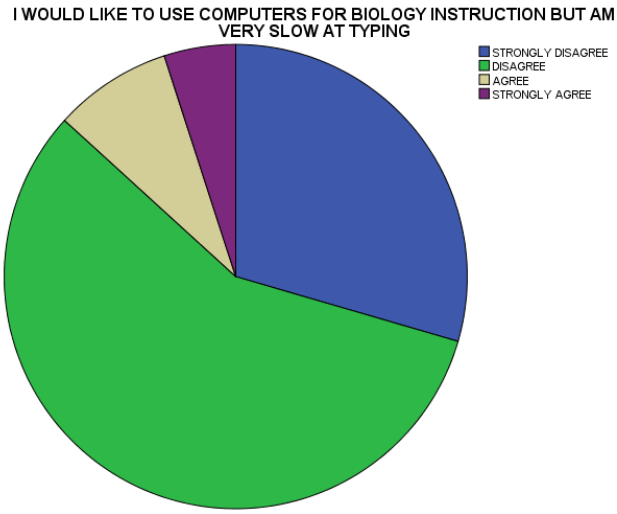

Figure 3: I'd like to Use Computer for Instruction but I'm Slow at Typing

It is can be deduced from Table 3 and Figure 3 that majority of the respondents refuted the proposition that they were slow at typing hence unable to use computers for Biology instruction. This was yet another good indicator of high competency in technological skills needed for Biology instruction. One other indicator of training needs for Biology instruction among pre-service teachers in this study was the areas that need skills improvement. One of the statements in the TTTNQ was designed to collect data to this effect and the results were as presented in Table 4 thus:

Table 4: There's nothing new to Learn on Use of Technology for Instruction

Response	Frequency	Percent
Strongly Disagree	118	29.5
Disagree	104	26.0
Not Sure	34	8.5
Agree	114	28.5
Strongly Agree	30	7.5
Total	400	100.0

The Table illustrates that 118 of the sampled pre-service teachers, which translates to 29.5% of the sample size strongly disagreed with the statement suggesting that there was nothing more than they could learn about the use of technology for Biology instruction. The Table further indicates that 104 of sampled pre-service teachers, which translates to 26%

of the sample size disagreed with this statement. Moreover, the Table illustrates that 34 of the pre-service teachers, which translates to 8.5% of the sample size were not sure of this, while 114 of them, which translates to 28. 5% of the sample size agreed with the statement. Additionally, the Table reveals that 30 of the selected pre-service teachers, which translates to 7.5% of the sample size strongly agreed that there was more to learn on the use of technology for Biology instruction. The same findings were presented on a pie-chart to give a more pictorial outlook thus:

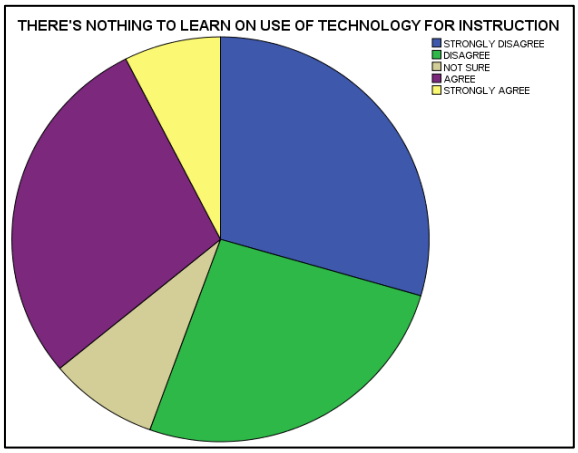

Figure 4: There's nothing new to Learn on Use of Technology for Instruction

Data presented on both Table 4 and Figure 4 clearly points out that majority of the respondents refuted the proposition that there was nothing new to learn on the use of technology for teaching Biology. This clearly indicated that most pre-service teachers have various training needs to equip them with more technological skills for effective teaching and learning of Biology at secondary school level. One other indicator of training needs for Biology instruction among pre-service teachers in this study was the number skills of technological skills already acquired from their respective universities. One of the statements in the TTTNQ was designed to collect data to this effect and the results were as presented in Table 5 thus:

Table 5: I've never been Taught Technological Skills for Biology Instruction at the University

Response	Frequency	Percent
Strongly Disagree	60	15.0
Disagree	155	38.8
Not Sure	75	18.8
Agree	110	27.5
Strongly Agree	60	15.0
Total	400	100.0

The Table illustrates that 60 of the sampled pre-service teachers, which translates to 15% of the sample size strongly disagreed with the statement suggesting that they had not been taught any technological skills for Biology instruction at their respective universities. The Table further indicates that 155 of sampled pre-service teachers, which translates to 38.8% of the sample size disagreed with this statement. 75 of them, which translates to 18.8% of the sample size were not sure of this. The table also reveals that 110 of the respondents, which translates to 27. 5% of the sample size agreed with the statement while 60 of the selected pre-service teachers, which translates to 15% of the sample size strongly agreed with the statement. The same findings were presented on a pie-chart to give a more pictorial outlook thus:

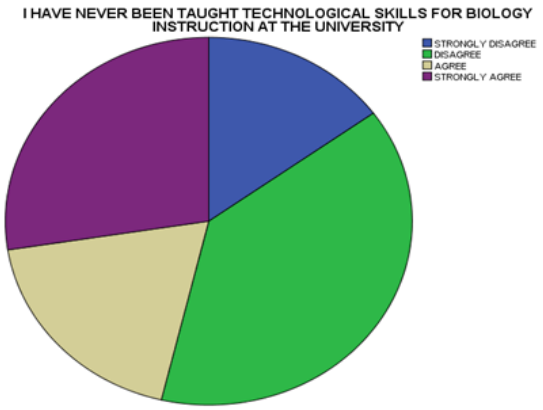

Figure 5: I have never been Taught Technological Skills for Biology Instruction at the University

The findings presented on both Table 5 and Figure 5 clearly points out that majority of the respondents refuted the proposition that they had not been taught any technological skills for teaching Biology at their respective universities. However, the number of respondents who affirmed this proposition was relatively high, which indicated that a good number of the selected pre-service teachers have various training needs to equip them with technological skills required for them to teach Biology at secondary school level. Another indicator of technological competency in Biology instruction in this study was the ability to draw simple Biological charts using MS Word. One of the statements in the TTTNQ was designed to collect data to this effect and the results were as presented in Table 6 thus:

Table 6: I can Draw Simple Biological Diagrams using MS Word

Response	Frequency	Percent
Strongly Disagree	16	4.0
Disagree	64	16.0
Not Sure	55	13.8
Agree	180	45.0
Strongly Agree	85	21.3
Total	400	100.0

The Table reveals that 16 of the sampled pre-service teachers, which translates to 4% of the sample size strongly disagreed with the statement while 64 of them, which translates to 16% of the sample size disagreed with this statement. The Table further illustrates that 55 of the selected pre-service teachers, which translates to 13.8% of the sample size were not sure, while 180 of them, which translates to 45% of the sample size agreed with the statement. Furthermore, the Table shows that 85 of the selected pre-service teachers, which translate to 21.3% of the sample size strongly agreed that they could use MS Word to draw biological diagrams. The same findings were presented on a pie-chart to give a more pictorial outlook thus:

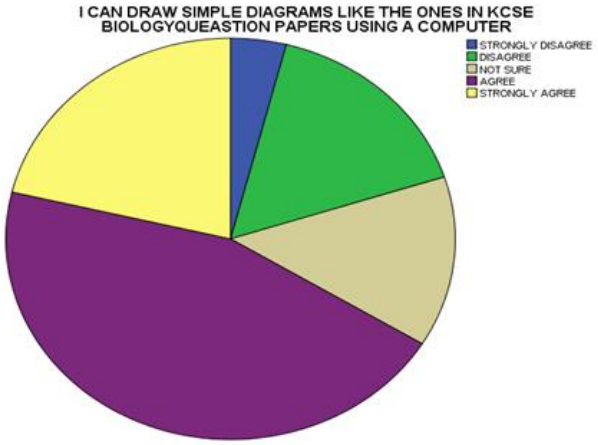

Figure 6: I Can Draw Simple Biological Diagrams Using Ms Word

It can be deduced from Table 6 and Figure 6 that majority of the respondents confirmed their ability to draw simple biological diagrams using MS Word. However, a good number also expressed their inability to do the same. This implies that there is a gap on the use of technology for Biology instruction in several pre-service teachers, hence the need for training on the drawing skills. Another indicator of technological competency in Biology instruction in this study was the use of internet as a resource for Biology instruction. One of the statements in the TTTNQ was designed to collect data to this effect and the results were as presented in Table 7 thus:

Table 7: I Know how to Use the Internet as Biology Instructional Resource

Response	Frequency	Percent
Strongly Disagree	0	0.0
Disagree	4	1.0
Not Sure	0	0.0
Agree	75	18.8
Strongly Agree	321	80.3
Total	400	100.0

The Table reveals that none of the sampled pre-service teachers strongly disagreed with the statement while only 4 of them, which translates to 1% of the sample size disagreed with this statement. The Table also illustrates that none of the selected pre-service teachers were unsure, while 75 of them agreed with the statement. Furthermore, the Table shows that a whopping 321 of the selected pre-service teachers, which translates to 80.3% of the sample size strongly agreed that they could use the internet as a resource for teaching and learning Biology. The same findings were presented on a pie-chart to give a more pictorial outlook thus:

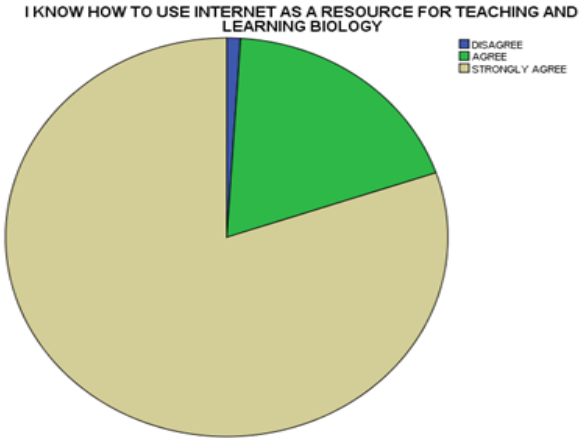

Figure 7: Use of Internet as Biology Instructional Resource

It can be deduced from Table 7 and Figure 7 that an overwhelming majority of the respondents confirmed their ability to use the internet as a resource for Biology instruction. This implies that there is no gap on the use of technology for Biology instruction in several pre-service teachers as far as internet use is concerned.

Responses to the statements in the TTTNQ all point out the fact that a significant number of the sampled Pre-Service Teachers have deficiencies in the use of technology for effective Biology instruction. The research question as earlier outlined was, "What are the biology teachers' training needs and competencies in the use of technology for instruction in Biology". Findings with respect to the this research question, following descriptive analysis of all items in the TTTNQ revealed that majority of sampled pre-service teachers were competent in; the use of internet as a Biology instructional resource, use MS PowerPoint slides, use of MS word, drawing simple Biological diagrams. However, the TTTNQ responses revealed that a significant number of the selected pre-service teachers have various technology training needs thus; drawing of Biological diagrams, use of windows 8 operating system, use of MS Excel and use of MS Access to analyze students' scores in the subject.

These findings are in agreement with those of Maina, (2018), whose study revealed glaring inconsistencies in the way pre-service Biology teachers were using technology to teach Biology, as some were highly competent while others were incompetent. Also in support of findings of this study with respect to the second research question is a study by Mdawida, (2017), who investigated the use of technology among pre-service biology teachers in Kwale County. Just like the present study, Mdawida, (2017) found out that

majority of pre-service teachers needed more training on the use of Ms. Access, MS Excel and drawing of Biological diagrams using the computer.

Findings of this study are however in contrast with those of Owens, (2019), whose descriptive survey that was carried out in Florida, USA, revealed that 98% of the pre-service biology teachers were highly competent in the use of technology for Biology instruction. The big difference in these two studies could be due to the fact that the latter, being a developed country has facilities and policies that ensure all learners are computer literate at the formative years of their education cycle, unlike the current study, which was done in Kenya, a third world country that continues to face challenges of power connectivity, hence limiting the implementation of the use of technology for instruction, especially in marginalized regions like Kwale county, as Mdawida, (2017) noted in his 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 technological content knowledge taught in most universities to prospective biology teachers is insufficient for their effective delivery of biology content at secondary school level.

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