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Changing Paradigms in Teaching of Practical in Biology in Selected Secondary Schools in Kakamega County of Western Kenya: A Case of Digital Educational Technology Media Resources

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Abstract

This survey study carried out to establish the competence and attitudes of teachers of Biology using Digital Educational Technology Media Resources (DETMRs), for the teaching of practical in Biology in Public Secondary Schools in Kakamega County, Western Kenya. Thirty-six Public Secondary Schools randomly sampled three from each of the twelve sub-counties of Kakamega County for data collection. For each sample school, the respondents were the Principals, Heads of Department (Science) and three teachers of Biology. The Principals of schools interviewed and questionnaire and direct classroom observation schedule for the teachers of Biology. Data collected analysed by descriptive and inferential statistics, Chi-Square (X^2) at a level of 0.05 of the statistics of significance. The findings indicated that the teachers of Biology lacked competence at13.83 percent, had poor attitudes, lacked knowledge and skills towards the use of DETMRs in the teaching of practical in Biology. The outcome of this study may benefit curriculum planners, teacher-education preparation programme developers and stakeholders in science education in improving the teaching strategies of the practical in Biology. As a digital era, all may impress a new paradigm shift in Biology practical instruction in a virtual teaching/learning environment.

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The recommendations are: to provide enhanced intensive teacher-education preparation programmes incorporating DETMRs for professional development of teachers of Biology. The teacher-education preparation programs to review technological, pedagogical and content knowledge base for the use of DETMRs in the teaching of the practical in Biology in the field, classroom, and laboratories.

Key words: Biodiversity; Biology; DETMRs; Paradigm; Pedagogy; Practical; PSS; Teacher-education; Virtual Specimens.

1. Introduction

Technology plays a significant role in the classrooms since the advent of a moveable analogue type in the 15th century. In the 16th century there were books, in the 17th century there were illustrations in books, in the 18th-century slate chalkboards, in the 19th century there were lantern slide projectors, in the 20th-century radios, motion pictures, overhead projectors, educational television and later, computers. Now, in the 21st century, classroom technology issues revolve around the use of Digital Educational Technology Media Resources (DETMRs) such as computers and the internet [38, 33]. Nothing assumed that has the potential to revolutionise education more than DETMRs. The teaching and learning of Biology base on the part and the whole of living things existing in their natural or human-made environments. The pedagogy is for real knowledge that enhances understanding and conceptual mapping and hence correcting the incoherence of pre-conceived ideas about the Biological conceptual mapping of living organisms. The changes in the environment have presented teachers of Biology with significant challenges for acquiring a real specimen for the practical in Biology pedagogical knowledge. It is harder than ever before for teachers to get relevant fauna and flora found in the proximity of school environment as community teaching and learning resources.

Biodiversity inventories not comprehensively done in Kenya. Therefore, different sources have made different estimates of species of both fauna and flora in Kenya. According to Mugabe and his colleagues [24], Kenya had between 8,000 and 9,000 species of plants, of which 2,000 species were of shrubs and trees. On the other hand, the National Biodiversity Strategic Action Plan, [34], showed that the country has about 34,379 species of wildlife, comprising of about 24,443 (17,455 being insects), of both animals and plants. Furthermore, Kenya boasts of exceptional climatic and ecological variations that contribute to the diversity of both plant and animal genetic resources. The ecological diversity in Kenya determines the distribution of bio-productive resources and the nature of economic activities undertaken [29]. The number of different species of animals and plants is by far above the average of other African countries. However, 15 of the 314 known mammals and 144 plants threatened with extinction due to climatic change witnessed in recent past decade. Wildlife (Conservation and Management) Act, CAP 376, created The Kenya Wildlife Service (KWS) as the body charged with the formulation of policies regarding the conservation, management, and utilisation of all types of fauna and flora. The Kenya Wildlife Service advises the government on the establishment of national parks, sustaining wildlife to meet conservation goals, administering, and coordinating international protocols and conventions relating to wildlife. The Service itself managed by a Board of Trustees charged with the duties of managing the Kenya Wildlife Service Fund (KWSF) and establishing wildlife advisory councils in areas where parks or reserves are situated. The gap in the management is that there is no realisation that both the school teachers and learners

should be involved in the conservations activities of living things for practical activities in the Biological Sciences. The involvement of the teachers and students would minimise the destruction of both flora and fauna for future generations.

Over the past decade, the government has spent many funds on laboratory equipment, computers and their accessory devices and setting up ICT centres in at least two selected Public Secondary Schools in every constituency. Through Kenya Institute of Education (KIE) unit (presently Kenya Institute of Curriculum Development – KICD) has prepared Electronic-learning materials for Forms 1 and 2. These instructional materials used with relevant support technologies like DETMRs, software and internet connectivity. The ministry of education responded to this situation that over 420 Public schools were set to benefit from the Government's ICT for a schools programme financial year at the cost of Kenya shillings 450 million. The schools were to bring to about 1,470, the total number of schools to benefit from the ICT programme in addition to previous year's 1,050 schools. However, the desire of the Government failed to provide the laptops to standard one pupil in public primary schools in Kenya as had been promised.

Many teachers feel ill prepared to utilise these devices effectively in a teaching of practical in Biology despite the near wide spread of DETMRs in Public Secondary Schools. Also, some authors argue that teachers need professional development to help them learn how to integrate technology into teaching and learning. There is the need for newer models for such development activities [13, 26]. Teacher's need for professional development was required before and during a development of E-learning materials by KICD for educators and supply of DETMRs to schools.

Global warming among other reasons is responsible for desertification, prolonged drought and the fall in the underwater table in some parts of the country, [35] that affect the availability of realia. The problem solved by the digital technology has made available virtual image animations and simulations for studies without having the living thing removed from the native environment. Teachers may use DETMRs for preparation, planning, assessment and instruction of concepts in Biological Sciences. The KNEC uses digital photographic specimens in Biology working paper three (233/3). The paper three is the KCSE examination, the actual biology paper that necessitates the teachers of Biology to acquire technological, pedagogical and content knowledge for competence in the subject area. Today's students have a short concentration span enhanced by the use of audio-visual virtual specimen in a virtual learning/teaching environment that may engage learner's throughout attention. Virtual Digital Specimen (VDS) that are audio-video digital photographic samples that are animated and simulated, requires minimal space for storage as diskettes, flash disks, CDs, Secured Digital card memory cards (SD) and video camera. Digital Virtual Specimens (DVS) are non-perishable, portable and more convenient to handle with no ethical factors as compared to real living organisms. Also, climate change and human activities do not affect digitally stored DVS. Apart from storage, competence and positive attitudes of teachers of Biology are required to meet the challenges faced during the process of planning, assessment and instruction of Biological sciences concepts while using DETMRs.

The Teachers find it hard to keep up with the demands of life and hard work when the education system fails to adapt to technology, as they feel bored with traditional teaching method of verbalisation and actual living

organisms with cultural challenges of some communities. Indeed, life in the Conceptual Age fully immersed in multitasking and technological diversity, and schools charged with the responsibility of integrating technological devices into teaching and learning [7, 36]. Presently, a well-educated learner knows how to obtain information, makes use of the information accessed, has advanced thinking, perception and problem-solving skills, processes information creatively, does not hesitate to assess and express him and can create new information by relating the data he obtains with future goals [45]. Therefore, DETMRs fit very well with the teachers, as changing the educational paradigm to find information thought worthwhile anywhere stored in the clouds for the teaching of Biology according to the constructivist theory of learning.

Besides challenges to integration of DETMRs in the teaching of Biology in secondary schools, there is a professional development that is hard to come by due competing priorities for finances. Besides, the availability and access to equipment, funding limitations, training, and instructional technology support are some of the challenges faced by teachers. Since new technologies are here to stay, to improve the competence and attitude of the teachers of biology, principals that control funds have to adapt to the use of DETMRs for the effective teaching of Biology using a virtual teaching and learning environments.

2. Materials and Method

2.1. Statement of the Problem

An advance in Digital Technology transformed by DETMRs has transformed the academic world into a global village Pedagogical, Technological and Content Knowledge (PTCK). Biological sciences now require teaching through Digital Virtual Teaching and Learning Environments (DVTLE) where digital images, pictures, simulations, animations and videos used along with sound instead of the actual specimen of living things. The virtual images might lessen environmental destruction due to the collection of realia specimens as a traditional paradigm from which a shift made towards the teaching of practical in Biology in secondary schools curriculum.

The Ministry of Education Science and Technology (MOEST) has produced Electronic-learning materials for Forms 1 and 2, which are yet to reach the schools. Since the Ministry of Education is rooting for ICT to be taught in all schools to improve quality, access and equity teachers require professional development to apply these DETMRs devices for the teaching of practical in Biology as changing paradigm of the 21st century. Because of this, the research sought to find out the competencies of teachers of Biology, in Public secondary schools on the use of DETMRs devices. Also, the attitudes of teachers towards the use of DETMRs for the teaching of practical in Biology in selected Public Secondary Schools of Kakamega County, Western, Kenya.

2.2. Objectives of the Study

To establish the competencies and attitudes of teachers of Biology while teaching of practical in Biology using DETMRs devices in selected Public Secondary Schools, the following objectives used for the survey study:

1. To establish teachers' competence in using of DETMRs for the teaching of practical in Biology in Public Secondary Schools.

2. To identify the correlation between teachers' attitudes and competencies towards the teaching of practical in Biology using the DETMRs devices in the classroom.

2.3. Research Questions

To collect data the study sought answers to the following issues:

1. What level of competencies did the teachers of Biology had in using DETMRs devices for the teaching of practical in Biology in the classroom in Public Secondary Schools?

2. What correlation existed between teacher's attitudes and competencies towards the use of DETMRs devices for the teaching of the practical in Biology in the classroom?

2.4. Significance of the Study

There is no documentation on DETMRs teachers' competencies and attitudes in planning, preparation, implementation, assessment and record keeping of teaching practices in Biology in the classroom in Kakamega County in Kenya. Therefore, this survey study exposed the competencies and attitudes of teachers of Biology toward the use of Digital Educational Technology Media Resources for the teaching of practical in Biology.

This survey study informs the stakeholders of the strengths and weaknesses of a professional development programme on DETMRs devices use in the SMASSE in-service offered. It also acts as an indicator to the curriculum planner, KICD, and assessment body, KNEC, to develop and organise appropriate educational activities to enhance the use of DETMRs for the teaching of practical in Biological Sciences in Public Secondary Schools.

2.5. Limitations of the Study

The research study was to find out the competencies and attitudes of teachers of Biology toward the use of Digital Educational Technology Media Resources for the teaching of practical in Biology in the classroom. How these devices manipulated during instruction, planning, assessment, records making and evaluation. The location for data collection was the Kakamega County, across 36 Public secondary schools. Three Public secondary schools randomly sampled from each of the twelve sub-counties that made up the county of Kakamega. The respondents were the Principals, Heads of the department for science and three teachers of Biology. This limitation was because of self-sponsorship and therefore financial constraints during data collection. The business constraints compounded with a short period to engage each teacher of Biology in all the selected schools of the Kakamega County. The other limitation of the survey study was vastness and terrains of Kakamega County. Some of the selected Public secondary schools had vast distances amongst them. Some of the schools were inaccessible during the rainy season in May through July. The survey study was limited to only Public Secondary Schools three randomly selected for each of the twelve sub-counties that make up Kakamega County, western Kenya.

3. Literature review

The literature review was on the competence and attitudes of teachers on the use of the DETMRs in classroom practical teaching of Biology in Public Secondary Schools. Technology Media used in classroom instruction in all subjects taught at the school for developed curricula. Nevertheless, with ever changing technologies from analogue to digital due changes of the needs of the society and changes of environment necessitate the change from the traditional way of instruction to modern technology that impresses DETMRs. The teachers of biology are required to have content, pedagogical knowledge and Technological knowledge to enhance the competence of the teachers. The teacher has to establish the relationships between Technology, Pedagogy, and Content Knowledge (TPCK) within the context they find themselves.

The human activities on Earth for settlement, agriculture and other economic activities have affected the climatic conditions consequently the diversity of living things. The earth's weather conditions, the cumulative conditions of precipitation, temperature and wind, have an impact on the growth, distribution and reproduction of various living organisms. The slightest changes in the atmospheric conditions or temperatures can affect the breeding, diet and migration behaviours of plants and animals including other living things. When climate change is so drastic that entire habitat changes, some animal and plant species eventually become extinct as they fail to adapt or find new habitats Intergovernmental Panel on Climate Change [20]. Climate change may result from both natural and human activities that have devastating effects on living things.

The regions that are most severely affected are often the regions that emit the least greenhouse gases. This one of the challenges that policy-makers face in finding fair international responses to the problems such as altering ecosystems and the many resources and services provided to each other and society. Many indigenous peoples live in harsh climatic environments to which they have adapted. However, when climate changes occur rapidly, populations with limited resources can be the first to suffer from a variety of hazards like famine and disease. Adaptation techniques include altering crop breeding and water infrastructure to deal with drought and improving public healthcare systems to reduce the harm caused by climate-related disease outbreaks [20].

The climate change and its effects can be demonstrated by use of DETMRs when using Virtual Teaching and Learning Environment for ecology in Biology. The traditional way of education cannot enhance teaching and learning of Biology as the virtual learning environment created by DETMRs does.

The expression "hands-on, minds-on" summarises the philosophy that students learn best if they are practically actively engaged in the classroom. The philosophy is if the activities closely linked to understanding important biological concepts for content knowledge. For example, it is helpful to use hands-on models using DETMRs to engage student interest, sustain concentration span and foster multiple modalities of teaching and learning in a virtual teaching and learning environment.

However, it is crucial to close linking the modelling activity to students' understanding of the actual biological processes. The ‘hands-on, minds-on' versions of manipulating of the real specimen and Virtual Digital Specimen offer a greater focus on linking the activity to students' understanding and learning of critical content

knowledge of biology for biological concepts. DETMRs virtual models used for teaching and learning where actual models are not available for a learner. In Kenya, the government is much aware of the potential of digital educational technology media resources to address some of the challenges in the education sector as some Public Secondary Schools chosen as centres of excellence and ICT centres. The concern is evident from the national plans and policies, which emphasises the role of DETMRs in education with various initiatives underway including digitisation of the curriculum that is under review by the Kenya Institute of Curriculum Development (KICD). The digitisation of the curriculum requires the professional development of the teachers of biology with the right competencies and attitudes for successful integration of Digital Educational Technology Media Resources (DETMRs) with a push for more relevant digitalised biological curriculum.

Teachers require new content knowledge, new pedagogical knowledge and digital technology experience for new skills (competencies) to integrate DETMRs and make them facilitators of learning rather than 'know-it-all' of knowledge. When all these three areas are combined, the teacher will make the transition of the paradigm shift from traditional practices of using realia to the digital technological delivery of content knowledge by use of DETMRs when the teaching of practical in biology in the classroom and field trips/work.

In addition to physical infrastructure through stimulus programs for some few chosen Public Secondary Schools, the attention should be on the provision of a quality education by re-training teachers using in-service courses to enhance competence and positive attitudes among teachers of biology.

At secondary school level, teachers use Educational Technology Media Resources in their classrooms when the practical teaching of practical in Biology. Increasingly, teachers have ready access to educational technology in their secondary schools and classrooms especially for chosen Public High Schools as centres of excellence and ICT centres. Teachers value many different types of Digital Educational Technology Media Resources for classroom instruction. The teachers have strong positive attitudes about the effects of digital educational technology media resources for their teaching and on students' engagement and achievement. Teachers agree that digital educational technology media resources contents are more effective when integrated with other instructional resources in the classroom, [30]. Teachers are progressively confident in their use, acceptance and attitudes toward digital educational technology media support. As Robert [30] continues to argue, the 2009 survey findings, conducted by Grunwald Associates, Limited Liability Company (LLC), revealed the following key findings:

- A majority of teachers using digital media, with applications including instruction, lesson planning, communications and professional development.
- Teachers who use digital media value them and believe it helps them, and their students are more productive than if they did not have digital media.
- Teachers continue to use video, and becoming more strategic in their media use and integrating it into their instructional strategies and resources.
- Teachers value many varied types of digital media, with games and activities for student use in school topping the list.
- Progressive numbers of teachers are joining virtual professional communities, and many are

comfortable using social networking tools in their personal and vocational lives.

The findings could be a likely reflection of the teachers in some Public Secondary Schools in Kenya accessibility of DETMRs than before. The decision to share the selected set of findings is especially interesting and useful to educators, policymakers and the stakeholders of education as a foundation for further studies in this area.

The advent of online professional communities and the explosion of social networking sites among adults seem to be capturing teachers' interest as well. Those teachers that use social networking sites are comfortable with a variety of online activities using Digital Educational Technology Media Resources for the teaching of Biology in a virtual teaching/learning environment. Digital technology fits into the old traditional paradigm of education. In this paradigm, best ideas kept to oneself, rather than sharing. Information not sought using digital educational technology media resources during a test, because it is “cheating.”

Subsequently, cannot take and employed in a new way other people's work; it will be "plagiarism." A cell phone not used as a support educational media because it is taking "unfair advantage." Nevertheless, modern digital educational technology media resources technology fits perfectly within the students' 21st-century educational paradigm, that is, find information thought worthwhile anywhere using DETMRs. Sharing of content knowledge of the digital curriculum developed through DETMRs by appropriate pedagogy with educators in real time and space done as early and often as possible. Teaching, which is getting harder in the old paradigm due to dwindling living things diversities, ought to be an easy method through using DETMRs for virtual teaching/learning environment. Imagine Form one upcountry student taught classification of living organisms found in the sea without the real specimen, and then the problem may be solved by the use of virtual sample developed by digital educational technology media resources for a virtual teaching environment. It is easy to use the internet through smart cellular phone, laptop or desktop computer to download virtual images of living organisms for education and learning purpose than looking for the real specimen that may hard to come by due to environmental effects.

In 30 years, which is within the working lifetime of today's teachers and students, the power of digital technology will have increased a billion times as digital educational technology and as well as social digital media technology. The technology companies introduce innovative products and services for the education; secondary schools have the opportunity to invest in digital technologies designed to improve instruction and operations for teaching, learning, assessments and evaluation of institutional, organisational efficiency. The greatest promise of anticipated digital technologies is the potential to transform secondary schools through innovation both academically and administrative management.

Teachers should drive students for changes in learning assisting them to handle the available digital media by allowing them to access them more frequently. Teachers to help students to actively carry out experiments collaboratively, and immerse themselves in new ways of communicating, learning, and getting things done using DETMRs in the classroom. Teachers' boldness and flexibility position them well to discover cutting-edge approaches to applying digital educational technology media resources creatively to the educational enterprise

for coverage of the curriculum within the prescribed time line. Educators, armed with increasingly powerful tools that help them truly make a difference in the lives of students; be able to approach their work with renewed purpose and passion as well [31].

It is important first to define what "technology integration" actually means. Perfectly, consistent the integration is when students are not only using technology but have access to a variety of tools that are appropriate for the task at hand and provide them with the opportunity to construct a deeper understanding of content knowledge of the subject matter. Subsequently, there are many ways to implement an interactive whiteboard to make it a tool for the students for instruction. Willingness and positive attitude to embrace change is a primary requirement for successful digital technology integration in the pedagogy. The digital technology is continuously and rapidly evolving phenomenon. It is an ongoing innovative process, and the pedagogical knowledge demands continuous renovation and learning.

The digital access includes, but is not limited to computer access, digital camera, LCD Projectors, Television, printers among others. According to researchers, DETMRs devices play a role in enhancing student skills, increasing motivation, and making the process of obtaining knowledge equitable [47,8,19]. Despite the strong push to get DETMRs technologies into instructional practices in Biological Sciences, many barriers to implementation still, exist [44, 11, and 18]. Several studies conducted to investigate barriers, which impeded the integration of technology in education [27, 41, and 25]. Of these obstacles, researchers point out the following factors that prohibit successful integration. Teacher-level Barriers were ensuring that students receive instruction designed to meet their educational needs to the highest expectation [28]. Using DETMRs technologies is one approach to supplement traditional methods of teaching and actively engage these students [21, 1, and 9]. Ertmer and Ottenbreit-Leftwich [37] noted that DETMRs technologies advancements in the classroom have been powerful, but until the teacher becomes an agent of change, the technological advancements will be incapable of producing the intended outcomes. With this kept in mind, it is important to understand teacher perceptions of technology concerning areas concerning students learning a life science, Biological Sciences with the scarce of the diverse living things.

Currently, many educators and administrators still see education as transferring knowledge to students. Teachers use the traditional method of teaching strategies that current student, none of this is education. To them, education is preparing for the future, their future, using DETMRs technologies that they are in constant contact with as social media such as smart phone. It begins with the prior knowledge they carry into the classroom that they know from all their everyday experiences to the world and its people [3] from television, You Tube, the Internet, chat and social networking. They follow their interests, learning things only as they become useful, sharing views along the way. More than anything else, students want their education to be meaningful, worthwhile, and relevant to the future. Those teachers who may be resistant to change due to digital technology, then the digital technology may change them, as it is there to stay and advance even more every passing time. The present generation of learners hates lecturing, as their concentration span is short. The 21st century is all about creating and inventing tools, art, videos, writing, programs, and simulations and sharing these things with an increasingly connected world [31].

While DETMRs technologies are more prevalent these days, the rate of which used practically for classroom instruction of Biology in Public Secondary Schools is varied [10]. Teachers' perceptions toward using technology for teaching and learning can have a significant impact on the frequency with which they use the technology. According to Marino [32] "As the global community continues the transition from an industrialised factory model to information and now participatory networked-based society, educational technology will play a pivotal role in preparing students for their futures". In education, we often hear the expression, "people tend to teach the way they were taught" [17]. If students emulate the practice of classroom teachers, the students' use of DETMRs technologies in social and educational contexts based on the examples set for them by their teachers [5, 17]. Since the technology was firmly interwoven in today's society and has become vital to human welfare and economic prosperity [16], the role of the teacher as a technology leader in the class is critical [15]. The impact teachers can have on students is significant and can lead to technologically literate students. Moreover, the assumption is that teacher's knowledge affects teaching and thus affects the learners' concept of and attitude towards technology [15]. Thus focusing on teachers perceptions of technology is essential for understanding what happens in the classroom practice. When attempting to integrate digital technology into their instruction, teachers refer to their existing beliefs and prior experiences. Current beliefs of teachers can influence the development of ideas about both technology integration and related practices [16]. Some studies on teacher perception have verified that teacher beliefs have an impact on the teachers' use of Digital Educational Technology Media Resources technologies in the classroom [16, 37, 39, and 2]. For example, Coppola (2004) conducted a study and found that teachers used Digital Educational Technology Media Resources technologies when they believed that it was useful and perfectly consistently integrated during instruction. Similarly, Snoeyink and Ertmer [42] indicate that when teachers recognise the value of using Digital Educational Technology Media Resources technologies for specific purposes, they were more likely to use DETMRs despite barriers.

School level administrators, the Principals, are responsible for the management of the student and teacher body about Digital Educational Technology Media Resources technologies practices [40]. However, studies indicate the lack of support, time, and resources from school leadership impede the usage of Digital Educational Technology Media Resources technologies [25]. Although each of the barriers as mentioned earlier is equally important, researchers found that time restraints, lack of planning, and scheduling computer time were also major restrictions vis-à-vis Digital Educational Technology Media Resources technologies usage by teachers [43,25]. If teachers expected to include DETMRs technologies into the curriculum, school administrators need to offer support for teachers as they begin to prepare technology-rich lessons at least with a technician. In the absence of good technical support, teachers not expected to overcome technology-related issues. In a study conducted by Pelgrum [46], teachers noted the top barrier to Digital Educational Technology Media Resources technologies use in education was the lack of technical assistance. Additionally, in Sicilia [6] did study, technical problems such as poor Internet connectivity, malfunctioning computers, slow Internet connectivity, and teachers have to work with old Pentium computers found to be significant barriers for teachers of biology. The researchers in this study concluded that technical barriers impeded the delivery of instruction as well as the natural flow of classroom activity, both of which, in turn, discouraged teachers from integrating Digital Educational Technology Media Resources technologies into their lessons [6]. The methods and ways that

DETMRs used determine the effectiveness of the instructional media. The only digital media resource independently not used. Wetzel [12] observed that for DETMRs to have an impact on biological science education the following strategies put in place:

Before using technology in the classroom, the teacher must decide what counts as technology. There are various uses of technologies; some are straightforward. Others are more recently such as digital media resources. Competence and the right attitude are necessary for efficient use of DETMRs in class for instruction in general. So much time as technology well used, it has the potential to revitalise teaching and learning. While some of these tools can be cumbersome, others are easy to use other than the use of computer and its accessories.

An example of a rather ordinary analogue but a still efficient use of technology is the overhead projector instead of the chalkboard. The overhead projector allows the teacher to type up notes or diagrams making transparencies that given to the students. Then, when it is time to teach on the material pre-prepared, the students may follow the instructions along on the sheet while also looking at the projected image on the screen. The example of this is when Deoxyribonucleic Acid (DNA) replication taught by distributing a diagram of the process to each of the students. Also, made of the picture drawn on transparency is displayed in the front of the classroom using the overhead projector. The pictures drawn are much easier than drawing the diagram on the chalkboard and having the students copy it. Only making notes on the transparency and pointing out key features of the process as the image projected for the students to follow. The preparation of the drawing on transparencies is the analogue type of technology that is more cumbersome to manipulate compared to the digital technology.

Another standard example of technology is television, presently digitalised. There are many great films on Biological Science topics available for use in the classroom with many simulations and animations. Documentaries on television or special programs on public television recorded for students in the classroom. The benefit of bringing this technology into the classroom is that students can learn about the topic from someone other than the teacher, a facilitator. For example, if there were a documentary exploring whether genes influence shoplifting, watching repeatedly and later discussing it. The discussion would probably be more interesting than listening to the teacher teaching on it. Moreover, films and television programs also provide a visual virtual environmental component to the content knowledge on the topic. For example, besides visiting the thick tropical rainforest (which obviously is not very feasible), to save on the agony, what better way to learn about life in it than to watch a streaming video? The animation of the forest used to study the nature of the woods without going into the jungle of trees. Surely, a streaming video is more exciting than reading a dry textbook with many words and a few colourful pictures scattered here and there at best. Another way of providing visual enhancements of a topic is microscopes. The examples when technology used during a study of photosynthesis to examine the structure of a leaf in detail. In chapter one, on the cell cycle to view prepared slides of cells going through mitosis, a chapter on taxonomy to display prepared slides of representatives from each of the five kingdoms of living organisms, or a lesson on osmosis. A video microscope is a particularly useful teaching tool as it allows images projected for the entire student population in the classroom at once so that all may see and discuss together.

There is a belief for a long time that competent teachers are those who can bring together their in-depth

knowledge of subject matter with the profound understanding of what is good for learning. Skilled teachers now are those who can bring together knowledge of subject matter, what is good for education and digital technology. The combination described as Technological Pedagogical Content Knowledge (TPACK). It is more than just adding DETMRs to traditional teaching pedagogy. It depends upon in-depth knowledge of how DETMRs can be used to access and process technological, content knowledge (TCK) and understanding how DETMRs can support and enhance learning (TPK) in combination with PCK. The competent teacher needs to make creative links between what is learned (content), how it was instructed (pedagogy), and the appropriate tools (technology) for the benefit of the learner.

There is a talk about the integration of technology into teaching and learning, the simple diagram below clearly illustrates the complexity and consideration that is required to do so. This model does not include the more debatable concepts in connectivity brought into play by the maturation of convergence of social media. The Technological Pedagogical Content Knowledge framework lays out the knowledge that Teachers need to integrate digital technology into their pedagogy successfully.

DETMRs may complement existing and emerging pedagogical approaches such as project-based, experimental, inquiry-based adaptive learning methods, hence facilitate the teaching of twenty-first-century skills. However, much been done more with DETMRs technologies to develop higher-order competencies and attitudinal qualities of the teachers of Biology. With effective collaboration and thoughtful implementation of DETMRs, the country may close the changing paradigm in pedagogical knowledge, technological knowledge and content knowledge of biological sciences skills gap of teachers' competencies.

4. Research Design and Methodology

To study the competence and attitudes of the Teacher of Biology utilisation of DETMRs for the teaching of practical in Biology in Public Secondary Schools of Kakamega County, Kenya, the researchers utilised descriptive survey design.

4.1. Population and Sample of the Study

A stratified sample of Public Secondary Schools selected whose teachers of biology, Heads of Department (science) and their principals included in data collection. The participants for this survey study chosen from a target population of 250 Public Secondary Teachers, and principals who work in these schools in Kakamega County of the Western region of Kenya. Three teachers of biology who taught in public secondary education with a certificate in the area of Science Education with biology and any other subject combination, a Head of Department (science) with or without biology as one of the subject combination and a principal in charge of the Public Secondary School. The stratification was not used in the data analysis instead the numbers of the DETMRs were the elements employed in the study.

4.2. Data Collection Tools

Instrumentation, the researcher selected a mixed-methods design because mixed-methods designs that provide

strengths that offset the weaknesses of using quantitative and qualitative research independently; mixed methods provide more comprehensive evidence as well as, an avenue for the researchers to solve problems numerically and descriptively [22]. This survey study included a survey-Questionnaire, direct classroom observation schedule and semi-structured interviews schedule designed to collect the same data.

The purpose of using the survey research was to take a broad view [4] from a sample of Biology Teachers in Public Secondary Schools implementing the use of DETMRs technologies for the pedagogy of practical in Biology in their classrooms. Finally, the researcher employed semi-structured interviews schedule of the school principals and Subject Head of Biology teachers that included observation program for two randomly selected biology lessons in each of the schools.

4.3. Data Analysis

Data analysis was significant to this study because it provided a lens through which the researcher could determine the competencies and attitudes towards the utilisation of DETMRs technologies for the pedagogy of practical in Biology in the classroom. Since this study was a mixed-methods design, the analyses of data were in two formats.

The quantitative analysed data by using frequencies and percentages and by calculating Chi-Square (x^2) from the items included in the survey Questionnaires instrument. Qualitative examined data sought to uncover categories, patterns, and themes that emerged out of qualitative data collected in various ways [23]. The respondents' qualitative responses data gathered through the interviews and direct classroom observations decoded into quantitative numerical values.

4.4. Ethical Considerations

The researcher sought the permission from the School of Education, Moi University. The Ministry of Higher Education, Science and Technology provided the research permit. The researcher visited the sampled public secondary schools and sought permission from the Principals to allow data collection in their schools. The researcher stated the purpose of the research to the respondents and asked their consent.

Punctuality observed not to interfere with the individual teacher's day program and the school programmes. The work plan followed for time management. The data collected kept confidentially and used only for the purpose this study.

5. Data presentation, analysis, interpretation, discussion and the findings

5.1. The Staffing of Teachers of Biology in Sample Public Secondary Schools, Kakamega County

The staffing of the teachers based on the Curriculum Based Establishment (CBE) principles. The CBE was the formulated policies for distribution of the teachers and used for the procurement of DETMRs.

Table 5.1: The Staffing of Teachers by Sex of both Principals and the Teachers (values in parentheses are %)

CATEGORIES OF TEACHERS	SEX		TOTAL (f) (%)
	MALE (f) (%)	FEMALE (f) (%)	
Principals	19 (9.45)	17 (8.46)	36 (17.91)
Teachers of Biology	108 (53.73)	57 (28.36)	165 (82.09)
Total Respondents	**127 (63.18)**	**74 (36.87)**	**201 (100.00)**

NOTE: In Table 5.1 and those that come later, (f) values not in brackets, represent the frequency occurrence number of the items against the total items specified. While (values in parentheses are %), represent the percentage representation of the elements of the total items specified.

From the Table 5.1, there were 19 (53%) male and 17 (47%) female Principals of the sample Public Secondary Schools. While, of the 165 teachers of Biology, 108 (65%) were males and 57 (35%) were females in sample Public Secondary Schools. The more male gender for the teachers of Biology as role models and mentors has a direct impact on the students' choice of career and other areas related to Biological Sciences as the subject area. The learners that are females might have the wrong attitude toward the Biology as a science subject. The poor attitude of women students might be a reflection of the competency of the teachers of Biology using the DETMRs for the teaching of practical in Biology in the classroom.

5.2. The First Objective of Research

5.2.1. Level of Professional Training of Teachers of Biology

The four levels of professional training of the Schoolteachers that taught Biology in selected public secondary schools; these levels were Certificate, Diploma in Education (Science), Bachelors of Education (Science) and Masters of Education as presented in Table 5.2. The professional training level expected to influence efficiency and competence among the schoolteachers in the field.

The professional qualification level of teachers of Biology investigation was to establish Content Knowledge (CK), Pedagogical Knowledge (PK) and Technological Knowledge (TK) as reflected by the degree of training. Table 5.2 shows one male teacher (1%) who had a Kenya Certificate of Secondary Education (KCSE). Twenty-seven (19%) of the teachers of Biology had a Diploma in Education (Science), of whom 20 (14%) were males and seven (5%) were females. Teachers who had Bachelor of Education (Science) were 100 (71%) of whom 73 (51%) were males, and 27 (19%) were females. Finally, 13 (9%) had Masters of Education, of whom nine (6%) were males while four (3%) were females. The females that had masters had taught for a longer period than male teachers. The number of women teachers was 38 (27%) while that of male teachers was 103, (73%)

indicated that for every one female teacher there were three male teachers. This observation was not an accurate reflection as there were 19 (53%) male principals and 17 (47%) female principals of the 36 selected Public Secondary Schools. The staffing of teachers by sex illustrated as shown in Table 5.2. Teachers who had Bachelor's degrees were more for male than female, but they outnumbered other qualification.

Table 5.2: Level of Professional Training of Teachers of Biology

SEX of RESPONDENTS					
Professional Qualifications	**MALE**		**FEMALE**		**TOTAL (f) (%)**
	Number of Teachers (f) (%)	**Number of Years Taught**	**Number of Teachers (f) (%)**	**Number of Years Taught**	
Certificate	1 (0.71)	1	0 (0.00)	0	1 (0.71)
Diploma	20 (14.18)	1-21	7 (4.97)	3-21	27 (19.15)
Bachelors	73 (51.77)	1-26	27 (19.15)	1-28	100(70.92)
Masters	9 (6.38)	4-21	4 (2.84)	16-18	13 (9.22)
Total	**103 (73.05)**		**38 (26.95)**		**141 (100)**

More males had Master's degree than women, and more males had Diplomas than females. This indicated gender disparity in the teaching of Biology in Public Secondary Schools. This disparity has an impact on student role modelling among the learners for identifying with the subject teacher of Biology.

5.2.2. The School Policy by Principals on the Use of DETMRs

The School Policy setup by Principals on the use of DETMRs was a deliberate principle to guide decisions and achieve outcomes for the proper use of DETMRs for classroom instructions of the teaching of practical in Biology and other academic subjects in the school curriculum. For the thirty-six sampled, Public Secondary Schools did not have uniform sets of the policies. There were six different systems, but one well-established school did not have any plan in place in addition to that of the Ministry of Education Science and Technology, as tabulated in Table 5.3. Each of the selected schools had a policy in places, besides, the one given by the teachers to guided decisions to achieve outcomes for the proper use of DETMRs for the teaching of practical in Biology and other subjects in the academic school curriculum. Those schools with few computer 14 (39%) were used for administrative work only. Ten (28%) schools, the policy was that both the teachers that taught computer as an examinable subject by KNEC and those students were taking the subject only accessed computers. Seven (19%) of the schools the policy in place encouraged teachers to use the computer in the presence of the technician. Three (8%) schools had two computers each whose policy was that computers were for the Principal and Deputy Principal. One (3%) of the schools did not have the academic system in addition to that of MOEST place. The government had given it thirty computers as a centre of excellence. Lastly, one (3%)

of the schools the policy was that computers meant for viewing of English and Kiswahili set books on literature only and yet did not have a LCD-Projector.

Table 5.3: The School Policy by Principals on the Use of DETMRs

School policy	**Number of schools (f) (%)**
(i). For Watching of set books	1 (2.78)
(ii). Teachers use only (Administration)	14 (38.89)
(iii). Students and Teachers (computer studies)	10 (27.78)
(iv). Teachers encouraged to use	7 (19.44)
(v). For Head Teacher and Deputy Teachers only	3 (8.33)
(vi). No school policy in place	1 (2.78)
Total	**36 (100)**

A scrutiny of these policies demonstrates how school teachers were motivated or discouraged to use the DETMRs in schools. The Principals required an in-service training course to sensitise on the importance of integration of DETMRs in the instruction for a Virtual Learning Environment (VLE) that enhances the learning of concepts in biological sciences.

5.2.3. Teacher Education Programmes

In the Table 5.4 that specified some of the expected areas for technological and pedagogical related applications in teacher preparation programmes to prepare teachers for field work. Those who stated that DETMRS used during the instruction in all plans were 160 (11%). Nevertheless, 640 (45%) reported the use of DETMRs for education in some programmes. However, 610 (43%) stated that nothing used during the instruction in the educational technology applications. With this information, it may infer that most of the teachers of Biology were not prepared to handle and use the DETMRs efficiently when teaching in the classroom. The efficiency is when the SMASSE INSETS are required to improve the proficiencies and abilities of the teachers of Biology for teaching practical Biology. About using multi-media digital content (for example digital audio or video) for instruction, nine (6%) indicated the use of DETMRs in teaching in the educational technology programmes. While 89 (63%) of the teachers reported that the DETMRs used during instruction in some programmes; However, 43 (30%) indicated that there was nothing used in teaching within the educational technology applications. Given what the Principals who stated during the interview that the teachers of Biology were computer illiterate in the area of DETMRs use in the classroom instruction may be correct since teachers never handled the gadget during the preparation in teacher education. Using content specific software tools for teaching (for example, graphic organisers, graphing tools, computer assisted instructional software) nine (6%) reported the use of DETMRs in education, then 63 (45%) indicated that DETMRs were used only in some of the programmes. However, the majority 69 (48%) stated that none of the DETMRs used during the teaching in

teacher programmes. Without familiarisation with content specific software, the teachers of Biology had a hard time to edit the images taken by either the smart phones of digital cameras. The image editing is an area that photographs required for teaching and learning in preparation for Biology paper Three of KCSE examination of KNEC. These situations frustrate the teachers that lead them taking the low profile in handling the DETMRs. Use of internet resources and communication tools for instruction (for example, accessing education materials, mobiles, virtual field trips) 12 (9%) indicated the use of instruments in teaching. However, 64 (45%) stated the use of tools in instruction in some of the programs and 65 (46%) expressed that the devices not used in teaching in any of the teacher education programmes. The only advantage of using internet resources and communication tools are with most of the people in possession of any Smart mobile phone that has internet connectivity. However, the problem is harnessing the application value of the instruments as the educational technology that promotes a practical virtual teaching and learning environment. Integrating DETMRs technologies into instruction 12 (9%) expressed that there was integration the technology in all the teacher education programmes. However, 91 (65%) stated that there was an integration of DETMRs only in some of the teacher training programmes. However, 38 (27%) of the teachers reported that there was no integration of DETMRs in any of the teaching of the teacher education programmes. The teachers stated during the interview that it was only during preparation for Teaching Practice exercise that they were encouraged to integrate DETMRs technologies in classroom instruction for teaching practical in Biology. Creating or using digital educational technology media resources (for example, Cameras for Photography) 17 (12%) expressed that there were the creation and use of DETMRs materials in all the teacher education programmes. However, 81 (57%) indicated that it was in some programmes. Nevertheless, 43 (31%) reported that the use of DETMRs not taught at all. Since most of the pre-service teachers, 124 (88%) did not have the chance to create and use DETMRs. These reflected in the field where teachers of Biology were not enthusiastic about making their photographs for classroom instruction due to poor attitude and lack of competence. Developing curriculum plans, these are programs that reflect the needs of its learners at the prescribed curriculum level, for example, Early Childhood and Primary Education (ECPE) that include using technology to address content standards. Twelve (9%) indicated that there was the development of curriculum plans that include using technology in educational technology. However, 69 (49%) reported that it was in some of the programs while 60 (43%) indicated that the plan not taught in any of the programmes. The curriculum plans that educational technologies developed for use during instructions include ECPE, Technical Education, Special School's Curriculum Models, and Secondary School Education Curriculum. The above reason is why standard one pupil provided with tablets or laptops to impress DETMRs in classroom instruction. Applying DETMRs, technologies in assessing student achievement concerning state curriculum standards, 16 (11%) respondents indicated that using technology in evaluating student achievement taught in educational technology. However, 62 (44%) reported that it was done in some of the programmes, while 63 (44%) respondents indicated that applications not taught in any of the programmes. During the interview of individual teachers of Biology, some of them stated that even if they were being in-serviced during SMASSE INSETS, they did not get the opportunity to apply these new technologies as the school policies were the barrier. The retrogressive policies set by the principals had the great impact on the attitude of teachers towards the use of DETMRs for the teaching of practical in Biology. Using DETMRs technologies to access or manipulate data to guide instruction, 17 (12%) respondents indicated that DETMRs used in teaching in all the programmes. However, 69 (49%) respondents stated that DETMRs used in teaching in some of the programmes.

Nevertheless, 55 (39%) respondents indicated that DETMRs not employed in educational programs. Using student assessment and evaluation strategies that involve DETMRs technologies (for example, report cards preparation, ranking), 56 (40%) respondents indicated that the strategies were taught in all the programmes while 52 (37%) respondents stated that the applications illustrated in some of the programmes. However, 33 (23%) respondents indicated that DETMRs not used in teaching taught in any of the programmes. When the teachers of Biology interviewed individually, they stated that they did not learn how to apply the DETMRs because of the large population of the pre-service teacher-trainees. The lack of acquaintance of teacher-trainees with manipulation of the DETMRs left them without the confidence to handle the equipment.

Table 5.4: The Technological and Pedagogical Knowledge Applications in Teacher-Education Preparation Programmes

Technological and Pedagogical Knowledge Related Applications	**Yes, in all programmes (1) (f) (%)**	**Yes, in some Programmes (2) (f) (%)**	**No (3) (f) (%)**	**TOTAL (f) (%)**
(i). Using multimedia digital content for instruction	9 (6.38)	89 (63.12)	43 (30.50)	141(100)
(ii). Using content-specific software tools for instruction	9 (6.38)	63 (44.68)	69(48.34)	141 (100)
(iii). Using internet resources and communication tools	12 (8.51)	64 (45.39)	65 (46.10)	141 (100)
(iv). Integrating technology	12 (8.51)	91 (64.54)	38 26.95)	141 (100)
(v). Creating or using digital media materials	17 (12.06)	81 (57.45)	43 (30.996)	141 (100)
(vi). Developing curriculum using technology for content standards	12 (8.51)	69 (48.94)	60(42.55)	141 (100)
(vii). Applying technology in assessing student achievement	16(11.35)	62 (43.97)	63(44.18)	141 (100)
(viii). Using technology to access or manipulate data	17 (12.06)	69 (48.94)	55 (39.01)	141 (100)
(ix). Using student assessment and evaluation strategies that involve technology	56 (39.72)	52 (36.88)	33 (23.41)	141 (100)
(x). Teaching via e-learning	0 (0.00)	0 (0.00)	141 (100)	141 (100)
TOTAL	**160 (11.35)**	**640 (45.39)**	**610(43.26)**	**1410 (100)**

Lastly, learning and teaching via distance and open E-learning 141 (100%) respondents indicated that learning

and education via distance and free E-learning not taught in the programme. Furthermore, a considerable representation of students training as teachers the infrastructure available could not support them due to their high enrollment into the course. Also, there was no provision of for distant and open learning and teaching.

To determine the significant differences between educational technology used for instruction in all or some or even not employed in Teacher Education programmes during training, a Chi-Square (X^2) calculated. The estimated value of X^2 =357.083, with degrees of freedom (df), =18, at the level of significance (α) = 0.05 of statistics, with the critical value of 28.869. Since X^2 = 357.083 was greater than the critical value (28.869) it was concluded that there was a significant difference between DETMRs and the Teacher Education programmes taught during training. The difference indicated a great impact on the use of DETMRs by teachers of Biology in the field. The great impact indicated when the responses, not taught at all combined with taught in some programmes, 1250 (89%) was a very high percentage that composed less competent teachers in the use of DETMRs technologies during classroom instruction.

5.2.4. The Use of DETMRs by Teachers of Biology for Classroom Instruction

From the previous section that 396 (56%) indicated that DETMRs not utilised within Teacher Education Program for their training, the researcher wanted to establish whether the same carried to the field. Upon interviewing the respondents, the data collected and collated as tabulated in Table 5.5, to find out the Extent to which Teachers of Biology used DETMRs Tools for classroom instruction of biology. To establish the extent of which the teachers of Biology used the DETMRs tools. The study found that 238 (34%) respondents did not use the tools at all. However, 224 (32%) respondents stated that the DETMRs tools were used to a minor extent. While (25%) reported that DETMRs tools were used to a moderate extent. Only 69 (10%) respondents stated that DETMRs devices used to a major extent for practical preparation in Biology, the paper three that involve photographs. For 636 (90%) of the responses stated that the policies that required specific performance of teacher of Biology put in place that affected the attitude of individual teachers negatively to use DETMRs tools for instruction in classrooms. The expression "hands-on, minds-on" summarises the philosophy that students learn best if they are practically actively engaged in the classroom. This expression was not the case here for the activities closely linked to understanding important biological concepts for content and technological knowledge for students. Respondents reported for having not enough time to plan for technology utilisation in the classroom and laboratories as there were insufficient funds for hardware and software needed for implementing technology into the education.

However, it is crucial to close linking the modelling activity to students' understanding of the actual biological processes. The 'hands-on, minds-on' versions of manipulating of the real specimen and Virtual Digital Specimen offer a greater focus on linking the activity to students' understanding and learning of critical content knowledge of biology for biological concepts. DETMRs virtual models used for teaching and learning where actual models are not available for a learner. In Kenya, the Government is much aware of the potential of Digital Educational Technology Media Resources to address some of the challenges in the education sector as some Public Secondary Schools chosen as centres of excellence and ICT centres. This choosing is evident from the national plans and policies, which emphasises the role of DETMRs in education with various initiatives

underway including digitisation of the curriculum that is under review with Kenya Institute of Curriculum Development (KICD). This digitisation requires the professional development of the teachers of Biology with the right competencies and attitudes for successful integration of DETMRs within the classroom instruction with a push for more relevant digitalised Biological curriculum. Teachers require new content knowledge, new pedagogical knowledge and digital technology experience for new skills (competencies) to integrate DETMRs and make them facilitators of learning rather than 'know-it-all' of knowledge. When all these three areas are combined, the teacher will make the transition of the paradigm shift from traditional practices of using real living organisms to the digital technological delivery of content knowledge by use of DETMRs when teaching of practical in Biology in the classroom and field trips/work.

In addition to physical infrastructure through stimulus programs for some few chosen Public secondary schools, the attention should be on the provision of a quality education by re-training teachers using in-service courses to enhance competence and positive attitudes among teachers of Biology. However, the DETMRs devices used to enhance or enrich classroom instruction, 33 (5%) teachers did not use any of the DETMRs devices at all. while 54 (8%) teachers used the tools to a minor extent. Those who moderately used DETMRs devices were 47 (7%) and seven (1%) used the DETMRs devices to a major extent.

The DETMRs devices used for understanding individual student learning styles, 60 (9%) teachers of Biology did not use the DETMRs devices at all. The teachers of Biology who used DETMRs devices to a minor extent were 50 (7%), while 30 (4%) teachers used the DETMRs devices to a moderate extent. There was only one (0.1%) response on the utilisation of the DETMRs tools to a major extent. Instead of only using standard paper and pen, essay and structured assessment, the use DETMRs integrated into the work and projects that provide the overall summative evaluation to understand the individual student learning style. This alternative assessment may provide a more realistic assessment in Biological Sciences and other subjects in the curriculum than traditional methods to understand the different student learning style.

The DETMRs devices for assessing individual student progress and challenges, 38 (5%) teachers did not use the DETMRs devices at all. While to a minor extent, 37 (5%) teachers used the DETMRs devices for assessment. However, only 26 (4%) teachers used the DETMRs devices to a significant scope in the preparation of KCSE Biology paper three, practical, on photographs for assessment. The teachers of Biology in PSS that had digital Cameras and digital colour printers used the devices to a major extent.

The DETMRs devices not used at all by 37 (5%) of the teachers of Biology for designing instructional interventions to individualised student instruction. Those teachers that used DETMRs devices to a minor extent were 54 (8%). The DETMRs devices used to a moderate extent by 43 (6%) of the teachers of Biology. However, seven (1%) of the teachers of Biology used DETMRs devices to a major extent in the preparation of photographs for Biology paper three practical.

The teachers of Biology interviewed to find if nothing done for DETMRs devices use due to competing priorities for the school and individual teachers. Seventy (10%) of the teachers stated that nothing is done with the DETMRs devices at all. Due to competing priorities to a minor extent were 29 (4%) teachers. Nevertheless,

the use of DETMRs devices to a moderate extent due to competing priorities were 14 (2%) teachers. To a major extent, competing priorities in the school considered the responses were 28 (4%). Since the DETMRs devices not needed seriously by the administration, Principals were not bothered to procure.

To find whether there was a significant difference between the use of DETMRs devices by teachers of Biology and the extent of usage, a Chi-square (X^2) was calculated. The calculated X^2 value was 96.970 at the degrees of freedom (df) of 12 and critical value (α) of 0.05 of statistics that was 21.026. The calculated value of Chi-square (X^2) was 96.970 higher than the critical value, 21.026 in conclusion. Therefore, there was a significant difference between DETMRs devices and the extent of their usage. Hence, the use of DETMRs devices did not have an effect on the classroom instruction by the teachers of Biology as this was by chance.

Table 5.5: The Use of Digital Educational Technology Media Resources by Teachers of Biology for Instruction

Use of DETMRs Tools by teachers of Biology	**The Extent of Use of DETMRs by Teachers**				
	Not at all (1) (f) (%)	**Minor (2) (f) (%)**	**Moderate (3) (f) (%)**	**Major (4) (f) (%)**	**TOTAL (f) (%)**
(i). Enhancing or enriching classroom instruction	33 (4.68)	54 (7.66)	47 (6.67)	7 (0.99)	141(20.00)
(ii).Understanding individual student learning styles	60 (8.51)	50 (7.09)	30 (4.26)	1 (0.14)	141(20.00)
(iii). Assessing individual student progress and challenges	38 (5.39)	37 (5.25)	40 (5.67)	26 (3.69)	141(20.00)
(iv). Designing instructional interventions to individualise student instruction	37 (5.25)	54 (7.66)	43 (6.10)	7 (0.99)	141(20.00)
(v). Nothing is done due competing priorities	70 (9.93)	29 (4.11)	14 (1.99)	28 (3.97)	141(20.00)
TOTAL	**238(33.76)**	**224(31.77)**	**174 (24.68)**	**69 (9.79)**	**705 (100)**

5.2.5. Barriers on a Teacher to Apply DETMRs Technology-Related Knowledge

Research indicates that learning enhanced when DETMRs devices used appropriately and more efficiently. The practical support that focuses on curriculum and DETMRs integration is the primary goal of modern digital educational technology for the 21st century as compared to the traditional analogue educational technology. The challenge is to provide adequate training of teachers and support staff to bring teachers at every point of the continuum from Techno-Phobia to Techno-Mania, thus, the teachers to train to the level of technical competence to meet learning objectives. To establish the barriers to the ability of a teacher to apply DETMRs

technology-related knowledge and skills the respondents probed and data collected and collated as presented in table 5.6. To overcome the barriers, the teachers require technical expertise, content knowledge and pedagogical knowledge, which may acquire through in-service training, hands-on and mind-on interaction with the DETMRs.

On the overall observation, 144 (13%) respondents indicated that there were no barriers at all for those teachers that were in PSS that had adequate numbers of computers. To the extreme, 27 (2.4%) respondents did not know that there were barriers since they were not aware that DETMRs were in place for use in the classroom pedagogy. When consideration is taken for moderate, major and Don't Know, the barriers 691 (64%) responds reported that the obstacles were real. The teachers require attention on technology, content and pedagogical knowledge on Technology-Related Knowledge and Skills barriers to applying DETMRs in the classroom. Lack of willingness of teachers to integrate DETMRs in the classroom pedagogy 115 (82%) respondents stated from to Minor Extent through the Don't know. There was the failure of willingness due to policies in place and or technophobia by the teachers that cited as a barrier. Twenty-six (18%) respondents were willing to use DETMRs for those schools that had adequate DETMRs. The lack of willingness of the teachers indicated a negative attitude towards the use of DETMRs for the teaching of practical in Biology blamed on restrictive policies put in place by the administration.

Lack of training or skills of teachers to integrate DETMRs in the classroom, 14 (10%) respondents indicated that lack of training or skills was not the barrier. One hundred twenty-seven (90%) respondents stated that the challenge was to provide adequate training and support DETMRs to bring teachers at every point of the continuum from technophobia to techno-mania to an appropriate level of technical expertise to achieve learning goals.

The issue of lack of time for teachers to integrate DETMRs in the classroom, 27 (19%) respondents stated that the matter of lack of time was not a barrier at all. However, 114 (81%) respondents reported that there was the lack of time as an obstacle to preparing to integrate DETMRs in the pedagogy of Biology as was cited earlier. However, as DETMRs as tools for teaching and learning the teachers had to find the time for preparing lessons and the integration of the planning unless the same teachers did not prepare lessons for teaching.

Limited technology knowledge and skills on the part of teacher, 12(9%) respondents indicated that limited technical knowledge and expertise was not a barrier at all. Competencies, nevertheless, 129 (92%) respondents stated that limited technical knowledge and skills were a barrier. These limitations pointed out that INSETs for the teachers by SMASSE were insufficient, inappropriate or inconvenient training.

There was the issue as there was no time that a follow up made to find what the teachers of Biology were doing in the schools. Competing priorities such as less number of Textbooks and electrical wiring 24 (17%) respondents cited vandalism in the classroom stating that competing priorities was not as a barrier. Nevertheless, 117 (83%) respondents reported that there were competing priorities, especially when it came to the covering of the syllabus due to less number of Textbooks; using DETMRs would interfere with time for individual attention to some of the students.

Table 5.6: Barriers on a Teacher to Apply DETMRs Technology-Related Knowledge and Skills

Barriers on a Teacher to Apply DETMRs Technology-Related Knowledge and Skills	**The Extent of Barriers on Teachers to Apply DETMRs**					
	Not at All (1) (f) (%)	**Minor (2) (f) (%)**	**Moderate (3) (f) (%)**	**Major (4) (f) (%)**	**Don't Know (5) (f) (%)**	**TOTAL (f) (%)**
i) Availability of DETMRs infrastructure	14 (9.93)	30(21.28)	50 (35.46)	46(32.62)	1 (0.71)	141(100)
ii). Lack of willingness of teachers to integrate DETMRs	26(18.44)	46(32.62)	43 (30.50)	23(16.31)	3 (2.13)	141(100)
iii). Lack of training or skills of teachers to integrate DETMRs	14 (9.93)	33(23.40)	34 (24.11)	57(40.43)	(2.13)	41(100)
iv). Lack of time for teachers to integrate DETMRs	27(19.15)	31(21.99)	33 (23.40)	47(40.33)	3 (2.18)	141(100)
v). Limited knowledge and skills on the part of teacher	12 (8.51)	37(26.24)	44 (31.21)	44(31.21)	4 (2.84)	141(100)
vi). Competing priorities	24(17.02)	36(25.53)	47 (33.33)	26(18.44)	8 (5.68)	141(100)
vii). Lack of DETMRs software	16(11.35)	30(21.28)	47 (33.33)	46(32.62)	2 (1.42)	141(100)
viii). Inadequate computers and accessories	11 (7.80)	23(16.31)	30 (21.28)	74(52.48)	3 (2.13)	141(100)
TOTAL	**144(12.8)**	**266(23.58)**	**328(29.08)**	**363(32.18)**	**27(2.39)**	**1128(100**

Lack of DETMRs software as support technology, 16 (11%) stated that lack of DETMRs software as support technology was not a barrier at all. These PSS were centres of excellence that had installed the internet software by Safaricom. However, 125 (89%) respondents stated that lack of DETMRs software as support technology was a barrier, although there was a belief that DETMRs were favourite tools for learning in Public Secondary Schools.

Lastly, inadequate computers and accessories, 11 (8%) respondents stated that inadequate equipment and accessories were not a barrier at all. These were the Public Secondary Schools that the Government had donated computers and accessories too, as centres of excellence. Nevertheless, 130 (92%) respondents regarded

inadequate equipment and accessories as a barrier that acted on the ability of a teacher to apply DETMRs technology-related knowledge and skills.

5.3. The Second Objective of Research

5.3.1. The Attitudes of Teachers toward Use of DETMRs for teaching of Practical in Biology

The teacher's attitudes towards enhancing or enriching classroom instructions were 33 (23%) that did not enhance or supplement classroom instructions at all. However, 54 (38%) indicated that had improved or enriched classroom instructions to a minor extent. Nonetheless, 47 (33%) developed or enhanced classroom instructions to a moderate extent. However, seven (5%) improved or enriched classroom instructions to a major extent. This observation was according to the data captured through the questionnaire. However, during direct classroom observations, 134 (95%) did not have any of the DETMRs for the teaching of practical in Biology, but only seven (5%) had the DETMRs and yet not adequately prepared pedagogically.

The respondents asked why the situation was in most of the schools. However, 70 (50%) of respondents said that competing priorities did not influence what happened. Nevertheless, the evidence suggested that 29 (21%) respondents stated that competing priorities contributed to a minor extent, 42 (30%) said that the contribution of competing priorities was both moderate and significant proportions. These study results provide some support for competing priorities in Public Secondary Schools made teachers of Biology to have a negative attitude towards the use of DETMRs for the teaching of practical in Biology during classroom instruction.

Further, the respondents asked their lack of willingness to integrate DETMRs in the classroom for the teaching of practical in Biology. Twenty-nine (21%) of the respondents stated that there was no effect of their lack of willingness to integrate DETMRs in the classroom at all. However, 46 (33%) it was to a minor extent, 43 (31%) it was to a moderate degree, while 23 (16%) stated that it was to a major extent.

Hence, the respondents asked if the lack of DETMRs software had any effect. Sixteen (11%) said that the lack of DETMRs software had not affected at all. Nevertheless, 125 (89%) of the respondents indicated that the lack of software affected functionality of the DETMRs. It was an issue even procuring an antivirus and modem for the protection of the computers against viral infection and internet connectivity respectively.

As observed in Table 5.7, respondents probed to find out whether the lack of interest in integrating educational technology in the classroom. Twenty-one (15%) stated that lack of interest in integrating educational technology in the classroom not an issue at all for the teaching of practical in Biology. However, 63 (45%) respondents stated that lack of interest in integrating educational technology in the classroom was minor, 38 (27%) to moderate, and 19 (14%) to extreme extents. On the overall 120 (85%) identified the lack of interest in integrating educational technology in the teaching of practical in Biology in the classroom pedagogy. The respondents probed further on the lack of interest of using DETMRs for teaching practical in Biology. Thirty-four (24%) of the interviewees stated that lack of interest was not an issue at all. However growing evidence provided that 107 (65%) support the lack of interest of teachers of Biology in the use of DETMRs for the teaching of practical in Biology in the classroom pedagogy.

From the evidence in Table 5.7, the 203 (24%) responses stated that there was no effect of the attitude toward the use of DETMRs in the classroom during the teaching of practical in Biology. The evidence suggested that the attitudinal impact affected the use of DETMRs in the classroom during the teaching of practical in Biology by 643 (76%) responses. Then this study indicated the concept that the respondents had a negative attitude toward the handling and use of the DETMRs technologies. The attitudinal impact showed confidence and competence of the interviewees handling the DETMRs due to deficiencies in technological knowledge and pedagogical knowledge.

Table 5.7: The Attitudes of Teachers toward Use of DETMRs for teaching of Practical in Biology

Attitudes of teachers toward use of DETMRs	**EXTENT OF USE OF DETMRs**				
	Not At All (f) (%)	**Minor (f) (%)**	**Moderate (f) (%)**	**Major (f) (%)**	**TOTAL (f) (%)**
i) Enhancing or enriching classroom instructions	33 (23.40)	54(38.30)	47(33.33)	7 (4.965)	141 (100)
ii) Nothing is done due to competing priorities	70 (49.65)	29(20.57)	14 (9.93)	28 (19.86)	141 (100)
iii) Lack of willingness of teachers to integrate DETMRs	29 (20.57)	46(32.62)	43(30.50)	23 (16.31)	141 (100)
iv) Lack of DETMRs software	16 (11.35)	30(21.28)	49(34.75)	46 (32.62)	141 (100)
v) Teachers' lack of interest in integrating DETMRs	21 (14.89)	63(44.68)	38(26.95)	19 (13.46)	141 (100)
vi) Teachers' lack of interest in using DETMRs in the classroom	34 (24.11)	46(32.62)	50(35.46)	11 (7.80)	141 (100)
TOTAL	**203 24.00)**	**268(31.68)**	**241(28.49)**	**134(15.84)**	**846 (100)**

5.4. The findings

Based on the analysis, interpretation and discussion of the data presented, the findings presented according to the objectives of the survey study.

5.4.1. The Findings Based On the First Research Objective

The survey study established that most of the teachers of Biology not exposed to DETMRs devices during the teacher training. Since most of the teachers of Biology not taught and prepared for the use of DETMRs devices, this was the evidence on the inefficiency and competencies on the use of technologies in the classroom pedagogy of Biology as established earlier.

The survey study found that the problems faced by the teachers of Biology were: few devices than expected, the lack of time for accessing computer peripheral accessory equipment, lack of technical knowledge to operate the devices connected to a system because they were not familiar with them. They were not able to assemble devices because they lacked interest due to school culture and policies that hindered the use of DETMRs devices in the classroom pedagogy of practical in Biology.

5.4.2. The Findings Based On the Second Research Objective

The study established that there was no effect of attitudinal impact toward the use of DETMRs in the classroom during the teaching of practical in Biology. However, from the previous observations, the teachers indicated a negative attitude and lack of interest in the handling and use of the DETMRs devices. The negative attitude and lack of interest might have been an indication of lack or no competence of teachers toward the handling and use of the DETMRs devices for classroom pedagogy of practical in Biology.

5.5. Conclusions and recommendations

5.5.1. Conclusions

The main factors that prevent school teachers from using computers as tools for education and learning were that there were no enough funds, fewer computers. Also, Teachers of Biology lacked computer knowledge that affected competence to integrate into different academic learning areas due to the absence of properly developed curricula for teaching computer skills. The enthusiasm for DETMRs devices use might well ultimately be the catalyst for transforming dominant traditional education practices and might improve on the teachers of Biology competencies for the teaching of practical in Biology.

The negative experiences lead the teachers of Biology to believe that DETMRs use was more problematic than helpful and likely reduce their technology knowledge use substantially. The study established that DETMRs technology-related training during SMASSE INSETs played a role in developing a teacher competency in computer and accessory devices applications that influenced positive attitudes. Hence the study established a correlation between teachers' attitudes and competence towards the use of DETMRs for the teaching of practical in Biology.

5.5.2. Recommendations

This study provides a basis for construction of technological, pedagogical and content knowledge through the use of DETMRs by the Teacher-education programme developers. Such an effort would enable teachers of Biology to acquire DETMRs knowledge derived through constructivist theoretical knowledge related to practical from a research based on virtual learning environment. It is through the acquisition of technological knowledge on the use of DETMRs that teachers will be competent and develop a positive attitude towards the utilisation of the devices.

There is a need for the Ministry of Education of Science and Technology to provide the DETMRs, especially the

computers (Laptops), digital Camera, colour printer and LCD Projector to the department of science as part of the equipment/apparatus of the Laboratory. The provision of the equipment might have a far reaching effect on the teachers' attitudes and competencies of the teachers of Biology.

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