International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

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 study aim was to establish the availability and use of Digital Educational Technology Media Resources (DETMRs) for the teaching of practical in Biology using virtual specimens. This necessitated by environmental changes caused by human activities and climate change affecting the availability of living things for the teaching of practical in Biology. This survey study carried on the teachers of Biology for the teaching of practical in Biology in 36 Public Secondary Schools (PSS) in Kakamega County, Western Kenya. The study guidance based on the constructivist theory of learning. Thirty-six PSS were 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 data was collected by interviewing of the Principals, while a questionnaire for the teachers of Biology and direct classroom observation schedule. The data collected analyzed by descriptive and inferential statistics, Chi-Square (X^2) at a level of 0.05 of the statistics of significance. The findings indicated that there were no adequate DETMRs in the PSS; the teachers lacked knowledge and skills towards the use of DETMRs in the teaching of practical in Biology. The study may benefit curriculum planners, teacher-education preparation programme developers and stakeholders in science education in improving the teaching strategies of practical in Biology.

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This may enhance conservation of the Biodiversity of living things for a future generation without destruction of the natural environment by collecting diminishing species of living things for the teaching practical in Biology. The recommendations are: there is need to provide DETMRs to PSS and support technologies by the government; the curriculum developers to provide enhanced intensive teacher-education preparation programmes incorporating DETMRs for professional development of teachers of Biology.

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

1. Introduction

It was hard to think that there was ever a time in history when teachers did not need to deal with "technology" and not faced with learning how to integrate technology into their daily practice of teaching. 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 [17, 14]. Nothing assumed that has the potential to revolutionize education more than DETMRs. The teaching and learning of Biology based on 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 specimen for 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 (1998), 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, [15], 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 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. 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 then, 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 by providing each school with 11 desktop computers, an LCD projector, printer and a laptop for the teacher, and accessories including a digital curriculum to selected two Public Secondary School per constituency. However, this was a pipe dream due to other competing priorities. The desire of the government failed to provide the laptops to standard one pupil in Public Primary Schools promised by the Government.

Despite the near wide spread of DETMRs in secondary education, many teachers feel ill prepared to utilise these devices effectively in a teaching of practical in Biology. 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 [5, 12]. 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. The effort placed on the primary school curriculum, especially the standard one pupil. The effort has far-reaching effects on the teaching of practical in Biology and at all levels of secondary schools curriculum across the academic subjects offered.

Global warming among other reasons is responsible for desertification, prolonged drought and the fall in the underwater table in some parts of the country 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 examination 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. Today's students have a short concentration span that can be 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 Digital video camera. Digital specimens are non-perishable, portable and more convenient to handle with no ethical factors as compared to real living things. Also, climate change and human activities do not affect digitally stored virtual specimen.

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 verbalization and looking for real living things all over the school environment. 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 [3, 16]. 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, [20]. 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 the challenges faced by teachers. Since new technologies are here to stay, 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. Because of the competing priorities in schools, some principals do not see the need to equip their schools with DETMRs devices for management and teaching in the classrooms. It is unfortunate scenarios faces by most classroom teachers of Biology.

2. Materials and Method

2.1. Statement of the Problem

Environmental, climatic changes and human activities have presented challenges regarding an availability of real living things for the teaching of practical in Biology. It is harder than ever before for teachers to get relevant fauna and flora for conducting functional activities in Biological Sciences in the field, classroom and laboratories. Many animals, plants and other living things threatened with extinction. The living organisms might get protection from the communities in which Public Secondary School located in line with Wildlife (Conservation and Management) Act, CAP 376. The greenhouse effect affected ecological habitats of living things, their survival and distribution and therefore availability for field visits and teaching of practical in Biology becomes a real problem due to the scarcity of the items.

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 real specimens as a traditional paradigm from which a shift made towards the teaching of practical in Biology in secondary schools curriculum.

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 availability, accessibility and use of DETMRs devices for classroom instruction in selected Public Secondary

Schools of Kakamega County, Western, Kenya.

2.2. Objectives of the Study

The objectives were to establish the availability and use of the DETMRs devices in selected Public Secondary Schools of Kakamega County, Kenya. The survey study indented:

1. To find out the availability of DETMRs in Public Secondary Schools for the teaching of practical in Biology.

2. To find out the accessibility and utility of DETMRs for the teaching of practical in Biology in Public Secondary Schools.

2.3. Research Questions

The survey study sought answers to the following issues:

1. What DETMRs devices available in Public Secondary Schools for the teaching of practical in Biology?

2. How were DETMRs devices accessed and used in the classroom pedagogical activity in Biology in Public Secondary Schools?

2.4. Significance of the Study

There is no documentation on Digital Educational Technology Media Resources availability, access and use in Public Secondary School of Kakamega County, Kenya. Therefore, this survey study provides a document on the state of availability, access and use of DETMRs devices for virtual education and learning environment for the teaching of practical in Biology in PSS.

This survey study informs the stakeholders of the strengths and weaknesses of DETMRs devices availability, access and use. 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 availability, access and use of DETMRs for the teaching of practical in Biological Sciences in Public Secondary Schools.

2.4. Limitations of the study

The extent of this survey study was to establish the availability, access and, use of DETMRs in the teaching of practical in Biology in Public Secondary Schools of Kakamega County, Kenya and on teachers of Biology in selected PSS. How these teachers accessed and used in the classroom the DETMRs devices. This constrained with the short period to engage each teacher of Biology in all the selected schools.

Besides, the other constraint of the survey study was vastness and terrains of Kakamega County. Some of the selected PSS had large distances amongst them. Some of the schools were inaccessible during the rainy season

in May through July. The survey study was limited to only three Public secondary schools randomly selected for each of the twelve sub-counties that make up Kakamega County, western Kenya

3. Literature review

There is a review of the related literature about availability, accessibility and utilisation of Digital Educational Technology Media Resources in the teaching of practical in biology in public secondary schools. These are the areas that the survey study concentrated on for establishment of availability, accessibility and utilisation of DETMRs equipment as the changing paradigm due to environmental change that has affected the availability of the living things for the provision of the real specimen for active classroom pedagogical content knowledge of organic content knowledge of the concepts.

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 cease to exist as they fail to adapt or find new habitats, Intergovernmental Panel on Climate Change, [6]. Climate change may result from both natural and human activities that have devastating effects on living things.

The importance of human activities has been increasing during the past few decades due to the population explosion that requires space for settlement and food production. Many natural and human-made gases contribute to the greenhouse effect that warms the Earth's surface. Water vapour (H_2O) is the most important, followed by carbon (iv) oxide (CO_2), methane (CH_4), nitrogen (1) oxide (N_2O), and the chlorofluorocarbons (CFCs) used in air conditioners and many industrial processes, [6].

The world's economy runs on carbon, the "fuel" on fossil fuels. Coal, oil, and natural gas contribute energy to nearly every human endeavour in the industrialised world, and carbon (IV) oxide (CO_2) is a by-product of burning these fuels. Immediately eliminating CO_2 emissions would stop the industrial world as raw materials and products are carbon based. 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, [6].

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.

3.1. Nature of Teaching of practical in Biology

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 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 DETMRs to address some of the challenges in the education sector as some PSS chosen as centres of excellence and ICT centres. The concern is evident from the national plans and policies, which emphasise 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 digitalized biological curriculum.

3.2. Where Digital Technologies Fits

Electronic learning, Educational Technology (ET), Information and Communication Technology (ICT), Computer-Aided Learning (CAL), Computer-Aided Assessment (CAA), Computer-Mediated Communication (CMC) - all these terms used interchangeably. Technology in its broadest terms includes electronics and traditional media like pens and paper**.** 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 DETMRs technology fits perfectly within the students' 21st-century educational paradigm, that is, find information thought worthwhile anywhere using DETMRs for internet connection. 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 using Virtual Specimens. 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 specimens developed by DETMRs 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 be 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, [13].

3.3. School Level Barriers for Availability, Accessibility and Utilisation of DETMRs

School level administrators, the Principals, are responsible for the management of the student and teacher body about DETMRs equipment practices [18]. However, studies indicate the lack of support, time, and resources from school leadership that impede the usage of DETMRs technologies [11]. 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 DETMRs technologies usage by teachers [19,11]. If teachers expected to include Digital Educational Technology Media Resources 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 (2001), teachers noted the top barrier to DETMRs technologies use in education was the lack of technical assistance. Additionally, in Sicilia’s study (2005), 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 DETMRs technologies into their lessons [2].

Types of Digital Educational Technology Media Resources technologies, which are useful in this context, include video games, simulations, on-line database, digital storytelling, music, graphic arts, virtual arts, modelling program, hand held devices and multimedia production tools. Wetzel's study (2008) stated that the use of these DETMRs provides many advantages to students that include:

- The ability to develop problem-solving skills of the real world.
- Development of sophisticated language skills by exposure to more conversational language experiences in the virtual learning environment.
- Mastery of subject matter content, through interaction with the application of language and symbolism, used in the real world context in the virtual teaching/learning environment-using DETMRs.

4. Research design and methodology

In order to study the Availability, Accessibility and Utilisation of DETMRs of teaching practical in Biology in public secondary schools of Kakamega County, Kenya, the researchers utilized 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 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 school 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. A list of 36 Public high schools compiled and the researcher contacted each of the public high school in person. The researcher obtained clearance from the Ministry of Education, Science and Technology (MOEST) and wrote an introductory letter of support to the participating the Public Secondary school. In all, the 36 principals of public high schools who gave consent and 144 teachers of biology contacted for the random survey's research.

The target population was 250 Public Secondary Schools in Kakamega County from which a sample of 36 (14.4 per cent) Public Secondary Schools, three from each of the 12 sub counties sampled were centres of excellence and ICT centres purposively sampled for data collection.

4.2. Sampling size and sampling Procedure

The sample size was four respondents of each of the thirty-six Public Secondary Schools. The Public Secondary Schools sampled were centres of excellence or ICT centres, extra-county high schools and county high schools. The stratification was not used in the data analysis instead the availability, access and utility of the DETMRs were the variables employed in the study.

The simple random sampling procedure used to select three teachers of biology in each of the PSS for the data

collection. The Principal and Head of Department (Science) for each institution were included. The 36 Principals of the sampled Public Secondary Schools had the one-on-one interview with the researcher to confirm the information given by the teachers. The same PSS used for direct classroom observation to establish the availability, access and utility of DETMRs during the pedagogy of practical in Biological content.

The purposive sampling procedure used to select Public Secondary Schools that were centres of excellent or ICT centres since these were the schools expected to lead others in having the high number of Digital Educational Technology Media Resources. They also had one teacher trained to train others in the use of digital technology in administration and academic education across the board in the institution.

4.3. Research Instruments

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 [8]. 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 [1] from a sample of teachers of biology for data collection. 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.

4.4. Data Analysis

Data analysis was significant to this study because it provided a lens through which the researcher could determine the availability, accessibility and utility of DETMRs devices in PSS 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 [7]. The respondents' qualitative responses data gathered through the interviews and direct classroom observations decoded into quantitative numerical values. Data analysis descriptive statistics (frequencies and percentages) and inferential statistic, Chi-Square (x^2) used in the analysis of the data. The analysis was done in two ways as follows:

4.5. 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 explained 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 of research.

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

From the previous studies, none dealt with the availability, accessibility and utility of DETMRs teaching practical of Biology in the classroom instruction, which this study endeavoured to seek out and the data analysis established the findings at every step subsequently.

5.1. Enrolment of Students, Streams, All Teachers, Teachers of Biology and Computers

Data collected and collated on the enrollment, the number of streams, all teachers in the sample schools and the teacher that taught Biology in the sample Public Secondary Schools. The enrollment of students determined the availability of the computers in each of the PSS. The data tabulated as shown below in Table 5.1.

A close look at Table 5.1, for the 36 PSS had a ratio of 1:24, thus, each school had an average of 24 (3%) computers. This standard did not reflect proper sharing of the computers among the streams of each class whose ratio stood at 1:7, thus, each stream had seven machines. This ratio would have been the accurate picture if the schools had the same enrollment. However, for the PSS that had lower enrollment had fewer computers, as few as three. These machines meant for the administration only, not accessible to the teachers across the academic curriculum as well as the students.

Table 5.1: Enrollment of Students Determining Streams, Teachers of Biology and Computers

Enrolment of Students Range	**Schools (f) (%)**	**Streams (f) (%)**	**All Teachers (f) (%)**	**Teachers of Biology (f) (%)**	**Computers (f) (%)**
250-300	2 (5.56)	4 (3.15)	26 (2.27)	3 (1.82)	12 (1.39)
301-400	3 (8.33)	6 (4.72)	49 (4.27)	5 (3.03)	50 (5.77)
401-500	2 (5.56)	4 (3.15)	37 (3.22)	7 (4.24)	11 (1.27)
501-600	6 (16.67)	18 (14.17)	119 (10.37)	14 (8.49)	130 (15.01)
601-700	8 (22.22)	22 (17.32)	245 (21.34)	40 (24.24)	159 (18.36)
701-800	5 (13.89)	20 (15.75)	174 (15.16)	26 (15.76)	109 (12.59)
801-900	2 (5.56)	8 (6.30)	78 (6.79)	10 (6.06)	60 (6.93)
901-1000	2 (5.56)	10 (7.87)	86 (7.49)	14 (8.49)	50 (5.77)
1001-1100	1 (2.78)	5 (3.94)	56 (4.88)	7 (4.24)	60 (6.93)
1101-1200	2 (5.56)	12 (9.45)	108 (9.41)	13 (7.88)	61 (7.04)
1201-1300	3 (8.33)	18 (14.17)	170 (14.81)	26 (15.76)	164 (18.93)
Total	**36 (100)**	**127 (100)**	**1148 (100)**	**165 (100)**	**866 (100)**

Even those eight Public secondary schools that had high student enrollment ranging from 601 to 700 had the

ratio of 1:7, thus, each stream had seven computers. The exact picture was that, for each of the PSS, of the total number of computers available, five used by the administration. The rest of the teachers in the school used what remained located in a computer room or an ICT-Room.

5.2. The First Objective of Research

The first objective sought to find out the availability of DETMRs in PSS for the teaching of practical in Biology in Kakamega County. The collected data collated as shown in Table 5.2.

Table 5.2: The Number of Computers per School, Teacher and Stream

Number of Schools (f) (%)	**Teachers Biology (f) (%)**	**Computers (f) (%)**	**Number of Computers Per**		
			School	**Teacher**	**Stream**
2 (5.56)	3 (1.82)	12 (1.39)	6.00	4.00	3.00
3 (8.33)	5 (3.03)	50 (5.77)	17.00	10.00	8.00
2 (5.56)	7 (4.24)	11 (1.27)	6.00	2.00	3.00
6 (16.67)	14 (8.49)	130 (15.01)	22.00	9.00	7.00
8 (22.22)	40 (24.24)	159 (18.36)	20.00	4.00	7.00
5 (13.89)	26 (15.76)	109 (12.59)	22.00	4.00	5.00
2 (5.56)	10 (6.06)	60 (6.93)	30.00	6.00	8.00
2 (5.56)	14 (8.49)	50 (5.77)	25.00	4.00	5.00
1 (2.78)	7 (4.24)	60 (6.93)	60.00	9.00	12.00
2 (5.56)	13 (7.88)	61 (7.04)	31.00	5.00	5.08
3 (8.33)	26 (15.76)	164 (18.93)	55.00	6.00	9.00
36 (100)	**165 (100)**	**866 (100)**	**24.00**	**5.00**	**7.00**

As Table 5.2 shows, the ratio of computers per teacher, stream for each school, the research found that, generally, the streams had higher ratios than the teachers did. This finding was not the actual picture as other teachers were equally using them and, therefore, many of the teachers did not even enter the ICT- rooms due to unfavorable competition.

One Public Secondary School had 60 (7%) computers against 12 streams as evidenced in Table 5.2 above. Thus, a ratio of 1:5, each stream exposed to five computers. Twelve of the computers used for administration, therefore, reduced to a ratio of 1:4, thus each stream exposed to 4 computers. These number of computers not enough for exposure of both the teachers of Biology and student for use.

There were four PSS that each had six computers, thus a ratio of 1:6 computers against eight streams. The computers used only for administrative purpose. These networks shared out as follows: the Principal had one, and so the Deputy Principal, the Accounts office, the Director of studies, the Examinations office and the Secretary of the Principal. For these PSS, computers were not available for both the teachers and students.

Twenty-two (61%) PSS each had 16-25 (2%-3%) computers. They had set up an ICT–Rooms or computer-rooms. Both the teachers that taught computer as an examinable subject with KNEC and the students that took the computer as examinable subject used the ICT-rooms. Other teachers, including the teachers of Biology, had little or no access to the computers.

Ten (28%) PSS that had the higher enrollment range of between 801-900 and 1201-1300 of students had 25 (3%) computers at the least and 60 (7%) computers the greatest number. They had established computer Laboratories managed by computer software trained technicians. Although both teachers that taught computer as an examinable subject, the students that took the computer as an examinable subject and other teachers that had the interests allowed to access and use them for other disciplines in the school under the strict supervision of the course technician. In fact, the teachers were more of on-lookers participants in the computer setup activities in the school according to the school policy. The student enrollment determined the DETMRs and peripheral accessories to the computer such as Printers, Projectors, Cameras, Digital Video Disk (DVD), Television sets, and ICT-Rooms. The data tabulated in Table 5.2 shows that the only device used together with the computer was the printer. The rest of the items, especially the cameras and Liquid-Crystal Display (LCD) Projectors were very few, and those available were not used to the level expected. The digital cameras are significant to a teacher of Biology for taking photographs that are part of the practical in Biology paper three of form four KNEC examinations. Some of the teachers said that their Smart Phones used to take pictures as virtual specimens. The images exported to the desktop or laptop then printed. Unfortunately, some of the Public secondary schools did not have colour-printers and therefore the teachers' sort help in the cyber cafes for colour print.

5.3. Availability of DETMRs in Public Secondary Schools

The time spent by the teachers in DETMRs correlates with increase student performance in Biology as was stated by some of the respondents. Therefore, adequate Digital Educational Technology Media Resources technological knowledge required. This support readily available is a condition that has been shown to promote integration in the teaching of practical in Biology content knowledge in the classroom.

To correlate the initiatives of SMASSE for the integration of DETMRs for the teaching of Biology the adequacy of DETMRs support sought. This research attempted to establish the DETMRs availability in conditions that

showed promotion of integration in the teaching in the classroom. The data collected tabulated as presented in Table 5.3.

While collecting the data on computers, Peripheral Digital Educational Technology Media Resources (PDETMRs) accessories items of the equipment sought also. The main PDETMRs regarded of primary importance were Printers, Cameras, Projectors, Television Sets, Video Deck and ICT- Rooms. For the teachers to use technology in the classroom instruction effectively, this research found these PDETMRs together with the computers to be the required equipment.

Table 5.3: Availability of DETMRs in Sample Public Secondary Schools in Kakamega County

Categorical Range of computers	**Number of Schools (f) (%)**	**Availability of Digital Media Resources in Sample Public Secondary Schools in Kakamega County**						
		Computers (f) (%)	**Printers (f) (%)**	**Cameras (f) (%)**	**Projector (f) (%)**	**TVs (f) (%)**	**VD (f) (%)**	**ICT-Rooms (f) (%)**
1-9	6 (16.67)	31 (2.69)	8 (0.69)	0 (0.00)	0 (0.00)	7 (0.61)	4 (0.35)	0(0.00)
10-19	8 (22.22)	103 (8.93)	20 (1.74)	6 (0.52)	3 (0.26)	10 (0.87)	8 (0.70)	6(0.52)
20-29	12(33.33)	288 (24.98)	45 (3.90)	6 (0.52)	11 (0.95)	21 (1.82)	13(1.13)	11(0.95)
30-39	3 (8.33)	92 (7.98)	11 (0.95)	1 (0.09)	3 (0.26)	4 (0.35)	2 (0.17)	2(0.17)
40-49	3 (8.33)	121 (10.49)	13 (1.13)	2 (0.17)	5 (0.43)	4 (0.35)	4 (0.35)	3(0.26)
50-59	3 (8.33)	162 (14.05)	17 (1.47)	4 (0.35)	3 (0.26)	4 (0.35)	4 (0.35)	3(0.26)
60-69	1 (2.78)	69 (5.98)	7 (0.61)	3 (0.26)	1 (0.09)	4 (0.35)	2 (0.17)	2(0.17)
Total	**36 (100)**	**866 (75.11)**	**121(10.49)**	**22 (1.91)**	**26 (2.26)**	**54(4.68)**	**37(3.21)**	**27(2.34)**

Observation of Table 5.3, the benchmark for the availability of the PDETMRs was the number of computers for the schools. There were 866 (75 %) computers available in the 36 sample Public Secondary Schools of Kakamega County.

For the entire sample Public Secondary Schools, 121, (11 %) had printers available, at least one printer and at most ten printers for each one of the public secondary schools. Each printer was serving at least four computers and at most ten computers. Most of the printers were not functional due to break down, lack of ink, software malfunction and hardware mechanical breakdown or all together. The Colour-Printers were fewer than the Black-and-white printers were. The biggest problem noted was the failure to have technicians to maintain the printers and other PDETMRs accessories. The ICT-Room laboratory technicians did not have knowledge of hardware but only some knowledge of software only.

Of the thirty-six Public secondary schools, six (17 %) did not have both digital cameras and LCD-Projectors consequently; there were no ICT-Rooms. There were 22 (2%) cameras of the total DETMRs available. Fourteen (39%) Public secondary schools did not have digital cameras. The availability of cameras together with digital printer would be of significant help to develop the much-required photographs that are part of the Biology practical examination paper three, of the Kenya National Examinations Council (KNEC), for Kenya certificate of secondary education (KCSE). Even for those Public high schools that had the digital cameras, most of the teachers had not used them as they were under lock and key by the Principals for fear of being lost and spoiled. In fact, one teacher commented that the Principal had encouraged them to use their mobile phones regardless of the make. The Principal based the argument on the notion of improvisation stressed during SMASSE INSETs. Those Principals that were not science teachers were the most adamant on improvisation of almost all the equipment required for teaching and learning by science teachers. This issue of improvisation demoralised most teachers, which explicitly reflected poor results in the KNEC examination results, results not shown in this research as was not part of the investigation.

Of the total available DETMRs, 26 (72%) Public Secondary Schools had LCD-Projectors; while 12 (33%) Public Secondary Schools did not have projectors and only two (6%) PSS had two LCD-Projectors each. Of the 24 (67%) teachers of Public Secondary Schools, only five (3%) of the sample teachers showed confidence in the use of digital LCD-Projectors. Three (8%) of Public Secondary Schools had the analogue projectors for transparencies which the teachers said that could not be in use as having transparencies and their mark pens was not a priority by the school management.

All the Public secondary schools sampled had at least one functional analogue Television, at most they were four television sets as was determined by the enrolment of the students. Of the sample schools, three (8%) did not have a video Deck (VD), and therefore the analogue television located in the staff rooms and not used as a teaching Digital Educational Technology Media Resources. There was no correlation between the availability of computers and television sets as computer had their monitors, while the number of TVs determined the number of DVDs

Ten (28%) sample, Public Secondary Schools did not have ICT-Rooms because they had six or fewer computers used for administrative purposes. Twenty-six (72%) Public Secondary Schools ICT- Rooms each and only ten (28%) of them had a technician to take care and make minor hardware repairs and maintenance. The Interview of the technicians on the safety, maintenance, and the quality of the processor of the computer, the research established that technicians had basic knowledge of what was required of them to do. The management set up policies to control the available computers in the schools.

5.4. The Second Objective of Research

The data collected for this objective collated and presented in Table 5.4.

The presentation indicated the values of the ratios of most frequently required DETMRs for efficient use during classroom instructions of the teaching of practical in Biology. The assumption was that the teachers of Biology

were accessible for the utilisation of the DETMRs. The other teachers of other curriculum subjects had an equal chance of using DETMRs for classroom instruction without interfering with teachers of Biology in the process.

5.4.1. Ratios of DETMRs in Selected Public Secondary Schools

Having the DETMRs is one thing, and the use of them is another due to competition for them by many teachers and the high enrollment in schools due to free education. For the establishment of the accessibility and the use, ratios carried out amongst the DETMRs as presented in Table 5.4. Visible all the schools had computers and printers both the cameras and LCD-Projectors were missing in some of the schools.

Table 5.4: Ratios of DETMRs in Selected PSS Categorical Range of computers

Categorical Range of computers	**Ratio of DETMRs**			
	School : Printers	Printer : Computers	Camera : Printers	School : projectors
1-9	1:1	1:4	0:8	1:0
10-19	1:3	1:5	1:3	1:0
20-29	1:4	1:6	1:8	1:1
30-39	1:4	1:8	1:11	1:1
40-49	1:4	1:9	1 :7	1:2
50-59	1:6	1:10	1:4	1:1
60-69	1:7	1:10	1:2	1:1
Average Total	**1:3**	**1:7**	**1:6**	**1:1**

From Table 5.4, each school had at least one printer and at most ten printers as determined by the enrollment of the students. Each printer served at least four computers and at most ten computers. Those printers that served more computers were likely to break down easily due to over working and lack of the ink rendering them useless as observed in some the schools. The research established on direct observation found that 32 (26%) of the available printers were not functional due to lack of ink and mechanical problems. An inquiry was made on the steps taken to correct the situation since computers cannot work entirely in exclusion of printers. The typical response was that the anomaly to be rectified in future when the funds are available.

Since the printer was one of the most important computer PDETMRs accessories, those schools that had fewer computers did not have Cameras for printers. Those schools that had the digital camera, each of them served at least three printers and at most eleven printers. Due to the scramble for a single camera by many departmental users, the teachers of Biology did not have a chance to use this gadget. This scramble demoralized the teachers that led to a lack of interest and competence even if they required the cameras to take photographs for training the students in accurate interpretation that is part of the Biology working paper three by KNEC for KCSE Examinations. Those schools that had fewer computers did not have LCD-Projector. One school had three

projectors of which two were LCD-Projectors and one Analogue-Transparency projector. The rest of the schools that had more computers each had one an LCD-Projector. Further, to establish the chances of using the DETMRs, it was correlated with the enrollment, the streams, the teachers of Biology and the number of computers for each school as presented in Table 5.5. Each of them had meaningful relationships with the other in the teaching of practical in Biology.

5.4.2. The Correlation of Students Enrollment, School Streams, Teachers of Biology and Numbers of Computers

There are needed to prepare tomorrow's teachers to Use DETMRs. Therefore, there is the need for the identification, through research, of the best practices in the use of DETMRs in teacher education to enhance efficiency and competence carried to the field after training by the teachers of Biology. Studies to determine the generalizable effects of DETMRs technologies in the teacher preparation programs are essential. DETMRs technologies play a fundamental role of the teacher in education, and therefore, there is the current need for in-depth training of teachers to use DETMRs actually to enhance competence. This preparation can be of use with enough availability of the DETMRs at the disposal of the practicing teacher for active classroom pedagogical knowledge in the teaching of Biology. The Correlation of Students Enrollment, School Streams, Teachers of Biology and Numbers of Computers presented in Table 5.5. The paradigm change in the teaching of practical in Biology is shifting from using real specimen to use for virtual images with the help of DETRMs. The virtual teaching and learning environment is what the 21st century holds for the teachers of Biology as most of the living things threatened with extinction and or far removed from the community environment. The DETRMs create a virtual teaching/learning environment that concretizes the teaching/learning process that is more meaningful. From Table 5.5, a stream had one or two teachers of Biology. While each stream had a minimum number of three computers to a maximum of twelve computers, the stream that had two teachers shared three or seven computers. Nevertheless, the other teachers of other academic disciplines in the school needed the use of computers. The numbers of computers were far less than the number of students. There was an average of 55 students per stream while the available computers used by a minimum of 18 students to a maximum of 82 students. The problem solved if LCD-Projector used. Only one LCD-Projector in the school against many streams and eleven or more academic subjects in the curriculum, depending on the school establishment, were the biggest emerging issues to handle due to free education. There were two instances that one stream had two teachers of Biology but the numbers of computers were three and seven respectively. The schools did not have an LCD-Projector; therefore, the teachers did not make any use of the computers.

If students used the computers, the ratio was one computer for a minimum of 18 students and a maximum of 82 students. For hands-on use of a computer for instruction in the classroom required only one computer for the teacher with an LCD-Projector and white screen or wall in the classroom. The problem arose when students were given assignments to do using computers. Where the ratio of Teacher to Computers was 1:2 it was possible for teachers to use a computer with an LCD-Projector to display information, but it was impossible for computer use by individual students. The digital media displays the virtual images of specimens seen by all the students in given classroom, space and real time for teaching of practice in Biology. Then another problem arises, sourcing of pre-prepared programmes of the content knowledge where internet connectivity is out of reach. The programmes should be of both animations and simulation to sustain the student concentration. Nevertheless, as

seen in Table 5.4, twelve (33%) sample PSS did not have Digital LCD-Projectors, out of which three (8%) had Analogue-Transparency projectors. Of the twenty-one (58%) schools that had LCD-Projectors, only five teachers (3%) of all teachers of Biology in five (14%) schools showed the capacity of how to use an LCD-Projector attached to a computer.

Table 5.5: The Correlation of Students' Enrollment, Streams, Teachers of Biology and Numbers of Computers

Students Enrollment	**Streams (f)**	**Teachers of Biology (f)**	**Computers (f)**	Ratio of Streams : Teachers: computers	Ratio of Computers : Students
250-300	4	3	12	1:1:4	1:46
301-400	6	5	50	1:1:10	1:21
401-500	4	7	11	1:2:3	1:82
501-600	18	14	130	1:1:9	1:25
601-700	22	40	159	1:2:7	1:33
701-800	20	26	109	1:1:6	1:34
801-900	8	10	60	1:1:8	1:28
901-1000	10	14	50	1:1:5	1:38
1001-1100	5	7	60	1:1:12	1:18
1101-1200	12	13	61	1:1:5	1:38
1201-1300	18	26	164	1:1:9	1:23
Total	**124**	**165**	**866**	1:1:7	1:29

5.4.3. Challenges Faced By Teachers of Biology Using DETMRs

Fifteen (19%) of the Principal stated that the majority 92 (65%) of the teachers of Biology were computer illiterate with very limited knowledge and skills to apply DETMRs technology-based as indicated in Table 5.6. The teachers of Biology had technophobia to handle computers with their PDETMRs accessories due to fear of breakdown. The technophobia followed by the frequent power outage that resulted in multi-functioning of some of the equipment software. Fourteen (18%) school policy discouraged teachers to work with computers. Ten (13%) stated that there were rampant theft and breakdown of the computers.

Ten (13%) of the selected schools, as was observed in Table 5.3, did not have ICT-Rooms and therefore all the DETMRs had been kept and confined in the Principal's offices. Eight (10%) of the Principals stated that there was the careless handling of computers and their peripheral accessories by both students and teachers because there were no technicians to take care of the DETMRs. Therefore, the teachers of Biology were restricted to handling any of the items. Six (8%) of the Principals stated that they lacked both computer technician for

maintenance and antivirus. These Principals asked the researcher what an antivirus was and where found. This inquiry of an antivirus indicated that some of the managers of the schools were equally ignorant and illiterate in the area of DETMRs. Five (6%) of the Principals did not buy cartridges for printers that had been exhausted as they deemed expensive and misused by printing many documents expected to be hand-written, such as schemes of work. They preferred to work with cybercafés than renewing or replacing cartridges. Four (5%) preferred to have Computers and printers for office use only due to competing priorities for insufficient financial resources available. Two (3%) of the Principal stated that even if the computers were available, most of the teacher lacked the interest to use and learn to use the computers and their accessories for teaching purposes.

Table 5.6: Challenges Faced by Teachers of Biology Using DETMRs

Challenges Faced by Teachers of Biology Using DETMRs	**Principals' Responses** **(f) (%)**
Majority of teachers are computer illiterate	15 (18.99)
Lack of interest for teachers	2 (2.53)
Lack of ICT rooms	10 (12.66)
Lack of computer Technician for maintenance	6 (7.60)
Supply of cartridges for printers	5 (6.33)
Computers and printers for office use only	4 (5.06)
Rampant theft of computers and/or breakdown	10 (12.66)
Lack of antivirus	6 (7.60)
Careless handling of computers by both students and Teachers	8 (10.13)
Frequent black-out of electricity	14 (17.72)
Total	**79 (100)**

6. The findings

Based on the analysis, interpretation and discussion of the data presented, the results presented according to the objectives as follows:

6.1. The Findings Based on the First Research Objective

This study has established that there was an average of 24 computers for each of the thirty-six Public Secondary Schools as was observed in Table 5.2. There were 866 computers in 36 sample Public Secondary schools. However, when compared with the number of streams, each was supposed to have seven (7) computers, and each of the streams had an average of 55 students. The reality was that the schools did not have the same students' enrollment. For the Public Secondary Schools that had a lower student's enrollment had few computers, as few as three (3), meant for the administration only, not accessible to teachers as well as the students in the school. The availability of the computers had an impact on use and integration in daily teaching

of practical in Biology.

If taken that, teachers of biology were the only ones to use the computers in the school, each of them could have had two computers for use, and the highest could have been ten against the high enrollment. The ratio of computers against streams found to be the range of 3 (three) to 12 (twelve) for each of the streams as indicated by Table 5.2.

There was one school that had 60 (sixty) computers against five streams, thus a ratio of one stream to 12 computers. Nevertheless, the sixty computers available, 12 used for the administrative management of the school, which reduced the proportion to one stream to 10 computers. The number of computers in each of the schools determined the number of PDETMRs accessory devices to the computers such as Printers, LCD Projectors, Digital cameras, DVD (videos), Television sets, and ICT-Rooms.

In the randomly selected schools, there were 121 (11%) of the PDETMRs whose ratio was at least three printers for each of the e schools. Each printer was serving at least four computers and at most ten computers. Ironically most of the printers were not functional due to mechanical breakdown, lack of ink, software malfunction or all together.

Of the 36 (thirty-six) PSS, six did not have both digital cameras and LCD projectors and no ICT-Rooms. There were 22 (1.908%) digital cameras of the total DETMRs educational technology available. Fourteen PSS did not have digital cameras. The availability of digital cameras together with digital printers would be of significant help to develop the much-needed photographs that are part of paper three, the practical biology paper of the Kenya National Examinations Council (KNEC), for Kenya Certificate of Secondary Education (KCSE). Even for those Public Secondary Schools had the digital cameras, most of the teachers had not used them as were under lock and key by the principals for fear of getting lost and damaged by the users. The Principals of the schools stuck to the notion of improvisation stressed during SMASSE INSETS of the science and mathematics teachers.

The research established that the use of the DETMRs in various schools reflected the enrollment of the students, the number of teachers of Biology and the interest of the teachers notwithstanding the school culture and the policy in place. The principals controlled and managed the computers available for use by all the teachers in schools for all academic curriculum subjects by setting up policies.

The study established that having the DETMRs was one thing and the use was another. The teachers competed for DETMRs for the other curriculum academic subjects in the school. This problem further caused by the high students' enrolment in schools because of subsidized tuition fees for secondary education by the National Government of Kenya.

For the Digital Cameras, those schools that had fewer computers than six did not have any Digital Camera at all for each of the available printers. Those schools that had the Digital Camera, each camera served three to eleven computers. The Digital Cameras demanded by all the departments in the school, most teachers of Biology did not have the opportunity to use them. The teachers of Biology did not produce their photographs for use by

Form Four candidates for KCSE students in preparation for KCSE Biology Practical Paper Three (231/3) set with photographic specimens.

For the LCD Projectors, the study established that those schools that had fewer computers than ten did not have an LCD Projector. One school was the only one with two LCD Projectors and one Analogue Transparency Projector. Each of the other schools had one LCD Projector. A further establishment was that the chances of using DETMRs technologies were related to students' enrollment, the number of streams for each form, the number of teachers and the number of computers for each of the schools.

There was evidence that the number of computers was the limiting factors for the teachers of Biology to use in the classroom for instructions. Also, the DETMRs peripheral accessory devices against an average enrollment of 55 students per stream limited the use.

The problem noted was the failure to have technicians to service and maintain the printers and other PDETMRs technologies accessory devices. Those specialists that were available did not have knowledge on mechanical functioning of the hardware but only some knowledge of the software especially the Microsoft word.

All the Public Secondary Schools sampled had at least one functional Television; at most, they had four Television sets, as was determined by the enrollment of the students. Three PSS did not have video deck (VD), and therefore, the television located in the staffroom, not used as DETMRs devices for teaching in the classroom. There was no correlation between the availability of computers and Television sets, as the computers had their monitors, while the number of TVs determined the number of video deck in the schools used for showing literature set books performance as drama.

Ten schools did not have ICT-Rooms as they had six or fewer computers used for administrative proposes only. Twenty-six schools had ICT-Rooms each, and only ten of them had a technician to take care, operate and make minor hardware maintenance and repairs where possible. The technicians had basic software knowledge as was established by the research for a one-on-one interview on safety, maintenance, the quality of the computers (Pentium) processors and the connectivity of the computer to the LCD projector, camera, TV and internet when the need arose to do so for classroom Biology instructions.

6.2. The Findings Based on the Second Research Objective

Furthermore, the study established that only five (3%) schools, of the twenty-one selected schools that had LCD projectors, the teachers of Biology showed the competence to use an LCD Projector attached to a computer. The five schools, whose teachers of Biology showed skill in using LCD Projectors, were the centres of SMASSE and therefore had the opportunity to access and used the items more frequently compared to other teachers.

Relatively it was established from individual Principals of schools during the interview stated that the majority of the teachers were computer illiterate. They had a phobia; the research refers to as Technophobia, the fear to handle computers with their peripheral DETMRs accessory devices. The Technophobia followed by the frequent power outages that resulted in failed to the function of some of the equipment and loss of data. The

schools did not have data recovery software installed on the computers. The problem of not recovering lost data discouraged most of the teachers to work with computers with their accessories digital devices. There were rampant theft and breakdown of the computers and their accessory devices that repair was not a priority for the management due to competing priorities for meagre funds available. Ten of the selected schools did not have ICT-Rooms; therefore all the DETMRs had been kept and confined to the Principals' offices. The Principals stated that there was the careless handling of computers and their peripheral accessory devices by both the students and the teachers as there were no technicians to take care of the DETMRs. So the teachers were restricted and prevented to the handling of any of the items. The study also established that some of the principals were equally ignorant and illiterate as the researcher asked what an antivirus was and where they would find. The administrators stated that even if the computers were available for the teachers of Biology, most of them lacked the interest and not willing to use and learn to use the computers with the accessory devices for teaching purposes with all the restriction imposed on them.

The research found one teacher of Biology in one of the schools who had a Kenya Certificate of Secondary Education (KCSE), a former student of the school, as the only teacher in completely two-streamed school. In Public Secondary Schools, there were more male teachers of Biology with Diploma in Education (science) than female teachers with the same qualifications. Bachelor of Education (Science) degrees holders, the male teachers of Biology were more than the female teachers. There were also post-graduate teachers with Masters of Education degrees, although fewer than the graduate and Diploma holders. More male teachers had Masters of Education degrees than the female teachers. The study also established that most of the teachers of Biology had a long teaching experience. The study determined that most of the female post-graduate teachers of Biology had taught for a longer period compared with the male teachers. The study also established that there were 38 (27%) female teachers as compared to 103 (73%) male teachers in the selected schools. There were 19 male Principals against 17 female Principals making 36 Principals of the selected Public Secondary Schools visited. This disparity indicated all levels of the profession that affected role modelling and mentoring of the students in line with the teaching of Biology as an academic and career subject in the schools. With the domination of male teachers, the students could easily conclude that Biology is a male subject that reflects in various jobs that relate to Biology as a subject.

After the examination of the barriers that impeded the integration of DETMRs devices in the pedagogy of teaching of practical in Biology, the respondents asked to evaluate themselves on the ability to apply DETMRs technology-related knowledge and skills acquired during the SMASSE INSETS and pre-service Teacher-education preparation programmes. The research established that three (2%) of the respondents stated that they could not apply DETMRs technology-related knowledge and skills acquired. However, the respondents that used DETMRs technology-related knowledge and skills obtained to a minor extent were 38 (27%). The respondents that were able to apply DETMRs technology-related knowledge and skills acquired to a moderate extent were 78 (55%). While the respondents that could use DETMRs technology-related knowledge and skills learned to a major extent were 19 (14%), and yet three (2%) of the respondents did not know to what extent they would apply DETMRs technology-related knowledge and skills acquired.

After an investigation into the application of DETMRs technology-related knowledge and skills acquired, the

researcher further examined the respondents to find out the pedagogical knowledge level of teaching of practical in Biology. The research established that 60 (11%) of the responses strongly disagreed to have acquired a level of pedagogical knowledge for teaching practical in Biology. Nevertheless, 141 (25%) of the responses somewhat opposed to having gained a level of pedagogical knowledge for teaching practical in Biology. However, 262 (47%) of the responses somewhat agreed to have acquired a level of pedagogical knowledge for teaching practical in Biology. Notwithstanding, 101 (18%) responses strongly decided to have gained a level of pedagogical knowledge for teaching of practical in Biology. The study made a follow up to verify by attending direct classroom instruction. The study established that the observation of some of the pedagogical knowledge level organisation of the lesson had many inconsistencies with the responses stated to have acquired a level of pedagogical knowledge for teaching of practical in Biology.

The examination of teachers of Biology on the barriers to instructional integration of DETMRs into the daily teaching and learning virtual environment of teachers of Practical in Biology. The study established that, while teachers taught on a daily basis, most of the teachers of Biology faced many barriers that impede their efforts to integrate DETMRs into the everyday teaching and learning virtual environment. Almost all the obstacles investigated were into play. Such barriers that hindered the efforts for integration were departmental DETMRs infrastructure, and the lack of training to use DETMRs in the classroom. The obstacles that followed the two above were teachers lacking interest, lack of time for developing the DETMRs knowledge and skills due to high workload. The other barriers were power outages, a significant number of students in the classroom, understaffing of teachers of Biology, lack of internet connectivity and lack of digital content materials.

The respondents asked whether there was professional development or training opportunities available to them in four areas. These four areas were: Use and application of Educational Technology Media Resources technologies; writing of schemes of work; teaching methods/planning; and assessment/instructions. The other opportunity was online training and distant learning. On the overall, 350 (50%) of the responses stated that there were professional development or training opportunities available to them, while 355 (50%) replies indicated that there were no professional development or training opportunities available to them.

7. Conclusions and recommendations

7.1. Conclusions

Using DETMRs devices to enhance the educational processes involves more than just learning how to use the particular piece of hardware and software. It requires an understanding of pedagogical knowledge principles that are unique to the use of technological knowledge in an instructional setting. Pedagogical based training starts with helping teacher trainees understand the value of learning theory in the design and function of class activities. The understanding includes the selection and use of instructional technologies. The based pedagogical training explicitly controlled by the content knowledge the teacher has acquired all along the teaching career. For this survey study, the conclusions based on the findings of the objectives and the research questions that guided the interview schedule and questionnaire research study for the collected data.

7.2. The Conclusions Based On the First Research Objective

This study established problems such few computer rooms, limited support software working, and no interaction among the teachers and computer technicians often act as barriers. Digital Educational Technology Media Resources treated not as a separate entity but considered as an integral part of instructional delivery in the teaching of practical in Biology. The teacher should be able to assess the appropriateness of any DETMRs used for teaching and learning about specific instruction. The teacher should also consider how the DETMRs selected for instruction fits into the objective of the content of the lesson, methods of teaching, evaluation, feedback and follow-up initiatives. Such consideration might provide teachers with the opportunity to reflect on their practice and reduce the tendency to integrate DETMRs into teaching and to learn in a mechanistic way. The school management should be encouraged to solicit the DETMRs devices for their schools to enhance technological, pedagogical and content knowledge for the teachers of Biology to be able to teach practical in Biology in a virtual learning environment.

7.3. The Conclusions Based on the Second Research Objective

The study established that most of the teachers of Biology did not use the instructional DETMRs to integrate into the classroom pedagogy. The teachers indicated a reflection of what happened during their preparation as teachers of Biology in the colleges. However, the scarcity of the DETMRs and the policies set out in schools had a significant influence on the access and use of the devices. Like other resource-teachers, they may be responsible for teaching students. The resource teachers could also provide in-service training and guide the teachers for professional development, and develop the curriculum, or perform similar types of duties and responsibilities as the department of curriculum, instruction and educational media may deem appropriate.

Digital Educational Technology Media Resources, especially computers and computer-related support technologies, have grown tremendously and have permeated all areas of our lives, social, economic and political. It is incomprehensible that anyone today would argue that banks, hospitals, or any industry should use less technology. Most young teachers cannot understand arguments that schools should limit DETMRs technologies access and use. For them, use of the Internet, for example, plays a major role in their relationships with their friends, their families, and their schools. Teens and their parents think the use of the Internet enhances the social life and academic work of teenagers. Therefore, raising the level of knowledge about digital Educational Technology Media Resources include the increasing the number of teachers for Science and Technology; and their students in Public Secondary schools using the technology tools of the digital age is an important national goal. The equipment increase in schools reflected as plans by the government to supply laptops to the standard one pupil in public primary schools.

7.4. Recommendations

Given the changing nature of examination using digitally taken photographic specimens by DETMRs in a series of The Kenya National Examinations Council examinations in Biology Paper Three (233/3) has increases the needs and potential of the educational technology be relatively current and future exposed to teachers without

personal bias. The human/technology interaction may be age-related or professional-development-related needs of the learners/teachers. As was observed in the literature review, the learners get more proficient in handling the digital items than their teachers because learners are in constant interaction with digital devices than the teachers.

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 constructivism theoretical knowledge related to practical from a research based on virtual learning environment. There is need for the Ministry of Education 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. This might have a far reaching effect on the teachers of Biology.

Acknowledgements

I would like to thank The Ministry of Education for equipping the Public secondary schools used for data collection and Moi University to have given me the opportunity for studies in Educational Technology.

I would like sincerely to thank my supervisors, Prof. Patrick Acleus Kafu and Prof. Chris Wekesa Mukwa for their professional guidance and encouragement during the writing of this study. Without them nothing would have taken the shape that this thesis took.

I cannot forget the encouragement of my family members all the period of the undertaking as there was family challenges that was almost became an obstacle.

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