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POST - CONFERENCE BOOK OF PROCEEDINGS

SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS EDUCATION INTERNATIONAL CONFERENCE (STEMEIC2020)

November 25TH - 27TH, 2020

Science, Technology, Engineering and Mathematics Education International Conference (STEMEIC2020)

November 25TH-27TH, 2020

POST-CONFERENCE BOOK of PROCEEDINGS

STEM Education during and post Covid-19: Integrating Pedagogy and Technology to ensure Resilience, Quality, Equity, and Sustainability

Hosted by

Masinde Muliro University of Science and Technology, Kakamega, Kenya

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PREFACE

The 1st Science, Technology, Engineering and Mathematics Education International Conference (STEMEIC) held on November 25- 27, 2020 at MMUST, Kenya, marked several exciting milestones for our institution. It was the first ever stand-alone international virtual conference in Kenya that attracted participants both locally and internationally. There were 46 presentations from scholars and practitioners from 8 countries, Kenya included, who participated in the conference. These highlights are important to mention because they demonstrate our contribution to the field of STEM education. The supportive and collaborative nature of the conference also builds on our vision "To be a Premier University in Science, Technology and Innovation" and mission "To provide excellent university education, training and research through integrating science, technology and innovation into quality programmes to suit the needs of a dynamic world".

This book of conference proceedings consists of a few selected articles from the STEMEIC2020. The contributions by the authors of the following proceedings reflect their dedication to STEM education in various settings and contexts. The proceedings not only build a legacy of scholarly contribution for the authors, but also for STEMEIC. I would like to thank all the authors who presented their research at the conference and ultimately for publication in this edition of proceedings.

More appreciation goes to the editors and reviewers for all their hard work on this book. As we continue to grow this as an annual event, your participation will increasingly be important to carrying out the work we are charged with from our mission.

Dr. Catherine M. Aurah
STEMEIC Chairperson 2020-2021

PURPOSE OF STEMEIC

Our Purpose is to help institutions of learning develop and sustain learning environments and programs suitable for STEM education. STEMEIC does this by:

- Providing a forum for professional educators to share resources and information about innovative pedagogies on a national and international level.
- Stimulating practitioner research, thereby contributing to the integration of theory and
- practice, and to the improved quality of our efforts.
- Serving as a vehicle for cooperative consultation and collaboration among professionals in the field.
- Integrating the interests and concerns from a variety of areas within STEM education.
- Promoting rights of underserved students.
- Influencing institutional and public policies concerning the principles of quality practice applied to STEM education.

Learn more at www.stemeic2020.org

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Rethinking Secondary School Science Teaching in Post Covid-19 Pandemic

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Abstract

Science is an important factor in the sustainable development of a country. In view of this, it is taught at all levels of education in Nigeria. At secondary school level, knowledge of science is fundamental to many professional courses in tertiary institutions, hence the need for its effective teaching. However, the sudden global pandemic of Covid-19, and the regulations for prevention of its continuous spread has affected approaches to teaching and learning generally. Based on the need to teach science and maintain Covid-19 safety protocols, the paper seeks teachers' new approach to the teaching of science in secondary school. Therefore, this study examined science teachers' planning for new pedagogies in the post Covid-19 pandemic. 200 Lagos State science teachers were purposively selected for the study being the most infected state in Nigeria. A structured questionnaire was used to collect data for the study. Data were analysed with descriptive statistics. Results revealed that many science teachers lack planning for new pedagogical strategies which can incorporate World Health Organisation (WHO) recommendations on prevention of spread of Covid19. However, few science teachers plan to break students into small class sizes. Considering the importance of teaching and learning of science in secondary schools, and the risk of Covid-19 infection, it is recommended that proprietors of secondary schools should organize workshops, seminars and conferences on new approaches and strategies to the teaching of sciences in the post Covid-19 pandemic situation. Some strategies which can facilitate the teaching and learning of science in secondary schools while observing the WHO regulations for control of Covid-19 were also suggested.

Keywords*: Science, Teaching, Covid-19, New Approaches, Teachers*

Introduction

Science has been described as any system of knowledge that is concerned with the study of physical and natural world. It can be described as the pursuit and application of knowledge and understanding of natural and social world following a systematic methodology based on evidence. Arubayi (2015) describes science as the knowledge obtained about the world by careful observation and experimentation. Omorogbe & Ewansiba (2013) also opine that science is organized body of knowledge in form of concepts, laws, theories and generalisations. From the foregoing, it is evident that science is concerned with the systematic study of natural and physical world through objective observation and experimentation. The knowledge contributes to the quality of life in many areas such as nutrition, health, agriculture, education, transportation, industries, etc. It is also important for personal and national development.

Science is the bedrock of sustainable development as it is important for technological development. Dahunsi & Oyedeji (2014) opine science is an important tool for technological development and advancement. Any developing country such as Nigeria, needs science knowledge to advance and compete scientifically and technologically worldwide. This may be the reason why the National Policy on Education, FME (2013) emphasize the need for teaching of science throughout all levels of education. The goals of teaching science in Nigeria were drawn from the national goals and philosophy of education as stated in the National Policy on Education (FME, 2013). These goals include:

Inculcate in the child the spirit of enquiry and creativity through the exploration of nature and the environment; Lay a sound basis for scientific, critical and reflective thinking; Provide opportunities for the child to develop life manipulative skills that will enable the child function effectively in the society within the limit of the child's capability; Provide trained manpower scientist, applied scientist, technology and sub-professional level.

The secondary school, students are prepared for their chosen career in tertiary institutions. Hence, the need to lay solid scientific foundation. In view of these, objectives of teaching science in secondary school were enacted from the general goals of teaching science as stated in the National Policy of Education. The objectives include to: cultivate inquiry, knowing and rational mind for the conduct of a good life and democracy, produce scientists for national development, provide knowledge and understanding of the complexity of the physical world and service studies in technology and the technological development. Due to the importance of teaching science, each of the science subjects at the senior secondary school (Biology, Chemistry and Physics) which this study considered also have specific objectives. For example, the objectives of biology include to - prepare students to acquire adequate laboratory and field skills in biology, acquire meaningful and relevant knowledge in biology, acquire ability to apply scientific knowledge to everyday life in matters of personal and community health and agriculture and reasonable and functional scientific attitude (FME, 2009). The chemistry objectives states – to acquire basic theoretical and practical knowledge and skills, develop reasonable entrepreneurial skills and apply the skills to meet societal needs of creating employment and develop interest in the subject in science, technology while the objectives of Physics include provision of basic literacy in physics for functional living in the society, acquire basic concepts and principles of physics as a preparation for after school studies, acquire essential scientific skills and attitudes as a preparation for technological application and to stimulate and enhance creativity.

At secondary school the knowledge of science leads to various science disciplines in tertiary institution, therefore the fundamental knowledge of science is very important at this level. To achieve the general and specific objectives of teaching science subjects, teachers are germane. In the teaching and learning process of science, teachers are to effectively plan the learning experiences, select appropriate methods of teaching, assessment, best actualization of the learning process, etc. The teaching of science should include varieties of activities which will engage students and assist in learning and development of scientific skills. Some of the methods used in the teaching of science include lecture, demonstration, inquiry, discussion, guided discovery, practical, laboratory, project, cooperative learning (Omorogbe & Ewansiha 2013; Arubayi, 2015; Adebayo, Sekoni, Lan, Odubayi, Akinyemi, et al, 2020). The methods are face -to-face, encourage delivery of large amount of information in a short period and effective in dealing with large class. The situation of science teaching at secondary schools has continued with the above methods and available resources such as laboratory, library, equipment and teachers, until the total lockdown of the country in March 2020 due to sudden global pandemic of the deadly disease – Covid-19.

Covid-19 stands for Corona Virus Disease of 2019. According to World Health Organisation (WHO) (2020), the disease is caused by severe Acute Respiratory Syndrome Corona Virus 2. (SARS – CoV2). The symptoms of the disease include acute fever, cough, sore throat, general weakness/fatigue, headache, nausea/vomiting, diarrhea, and it is spread through contact with respiratory droplets of an infected person such as saliva, mucus or any other matter from respiratory surface.

In order to prevent further spread of the disease, WHO gave mandatory regulations which include:

- Social distancing – keeping at least 2m distance from people to prevent being contacted by sputum of infected persons,

- Wearing of face masks in public places to prevent inhaling infected air or infected droplets of infected persons.

- Regular washing of hands with soap and running water/ use of alcohol-based sanitizer which is at least 70% alcohol in the absence of soap.

- Avoid hand shaking and hugging.

- Avoid touching of nose, mouth and face.

Before the total lockdown of schools and other places as a result of the pandemic and the science teachers have been planning and teaching sciences using the methods and resources as stated above. However, in the post pandemic situation, Covid-19 protocols have to be observed while teaching science. It is the responsibilities of science teachers to plan how to integrate the Covid-19 regulations/protocols and teach effectively in science classroom. The situation of incorporating Covid-19 regulations while teaching is referred to as the new normal. Previous studies on science teaching and post Covid-19 pandemic has been on students' performance (Oyinloye, 2020), impact of the crisis on facilitation practical activities (Chadwick & McLoughlin, 2020) but none is available to best of the knowledge of the researcher on the rethinking of approaches and methods of teaching science in the pandemic.

Therefore, this study examined teachers' planning in the teaching of sciences toward integration of regulations against the spread of Covid-19 in the new normal situation which is conscious to avoid the spread of the disease.

Science plays a major role in the development of a country. It is taught at all levels of education to facilitate its learning for future applications at individual and national levels. At the secondary school level, the knowledge of science serves as the basics or fundamentals to many disciplines at tertiary institutions, hence the need to be taught with various strategies which can facilitate effective and efficient students' learning. In the year 2020, there was an emergent outbreak of an infectious diseases – Covid-19. The outbreak of the disease led to global shut down of schools and total lock down in which no one could go out due to high level of contagiousness of the infectious disease. On gradual ease of the lockdown, Covid-19 regulations or protocols to be observed to prevent continuous spread of the disease were rolled out by WHO. Occupants in schools are not exempted from the compulsory guidelines or regulations in order to open and operate the teaching and learning process. In view of this, it is important for science teachers to plan on the new approaches and strategies for teaching that will discourage face to face teaching in order to observe social distance and other Covid-19 protocols. Therefore, this study examined the plans and strategies secondary school science teachers employed in order to integrate the regulations for the prevention of the spread of Covid-19 while teaching.

Sampling Technique and Sample

A descriptive survey design was adopted for the study. In Nigeria, out of thirty-six states in the country, Lagos has continuously been the most infected state with 20,809 laboratory confirmed cases (National Centre for Disease Control, Lagos. Nigeria. 26th October 2020). In view of this, Lagos state was purposively selected for this study. In this state, there are twenty Local Government Areas (LGA), ten science teachers (biology, chemistry and physics teachers) were randomly selected from both private and public secondary schools in each of the twenty LGA. In all, a total of 200 science teachers participated in the study.

The instrument for data collection is Teachers Planning for Post-Covid-19 Pandemic Science Teaching (TPPCPST) which is a structured questionnaire. The instrument was divided into sections that demographic information, open-ended questions on challenges for teaching science in the post pandemic, new plans and methods to approach teaching science in the post pandemic and teachers' plan to utilize technology for teaching science. The instrument was given to two experts in research and science education for content validity. The constructive comments made by the experts were included in the instrument. Thereafter, interrater was used to establish the reliability of the instrument. An estimate of 0.75 was obtained. The instrument was administered to the science teachers through their email addresses collected from their respective schools with the help of two research assistance. The data collected were analysed descriptive statistics including graphical representations.

Results

Results are presented according to research questions.

Research Question One: What are challenges of teaching science in post Covid-19 pandemic?

The responses given by the teachers are represented in the graph below:

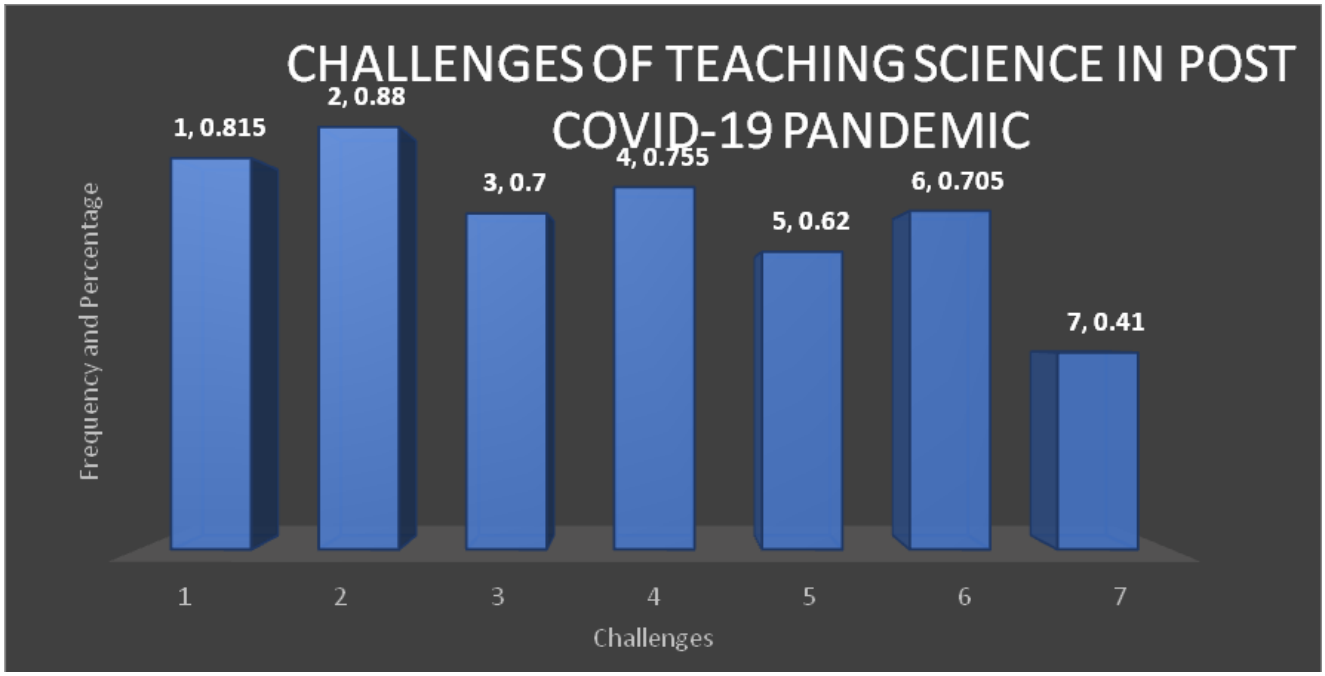

Figure 1: Challenges of teaching science in post Covid-19 pandemic

Key: 1 – limitation in selection of teaching method; 2 – Shortage of instructional materials; 3 – Lack of resources for practical; 4 – group work during practical; 5 – lack of space; 6 - more teaching loads due to breaking of large classes; 7 - assessment of students

The challenges listed by the teachers include: problem of teaching methods to use in teaching 163 (81.5%), shortage of instructional materials 176 (88%), lack of enough resources to carry out practical 140 (70%), inability to carry out group activities during practical 151 (75.5%), lack of enough space to spread out students 124 (62%), more teaching loads as a result of breaking large classes into small sizes 141(70.5%) and problem of assessment of students without physical contacts 82 (41%).

Research Question Two: To what extent do teachers plan to solve the challenges of teaching science in the post Covid-19 pandemic?

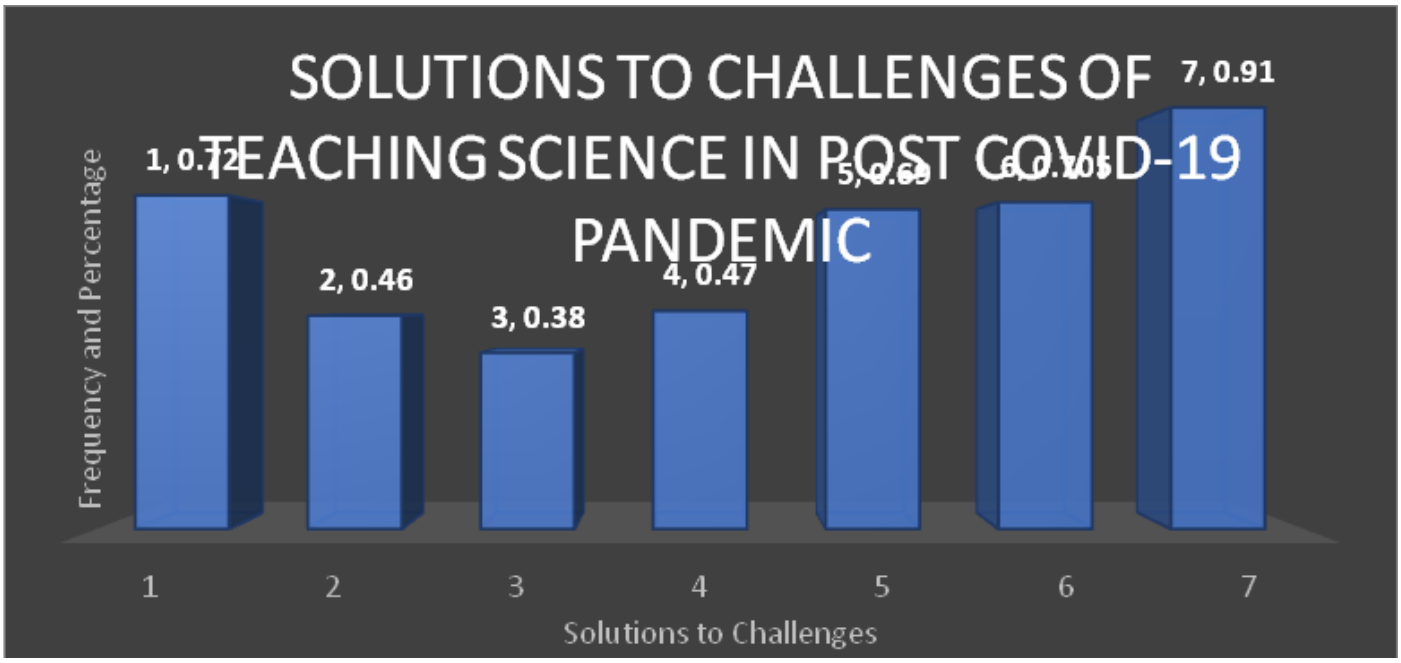

Figure 2: Solutions to challenges of teaching science in post COVID-19 pandemics

KEY: 1 – Use teaching methods that prevent physical contact; 2 – Break students into batches to use instructional materials for different batches;

3 – Divide students into groups for practical;

4 - Break practical classes into different batches;

5 – Suspend practical exercises;

6 – Break large classes into more arms of classes;

7 – Space out students based on available classroom

In response to how the science teachers plan to solve or overcome possible challenges of teaching science in post pandemic, some teachers plan to use teaching methods that will prevent physical contact 144 (72%), break students into batches in order to use the same set of instructional materials for different batches 92 (46%), while some also suggest division of students into groups for practical 78 (39%), break practical classes into different batches 94 (47%), suspend practical classes till after the Covid-19, 138 (69%), break large or overcrowded classes into smaller class sizes 141 (70.5%), while those who responded to space students based on the school's available classrooms were 182 (91%).

Research Question Three: To what extent do teachers plan to utilize technology in teaching science in the post covid-19 pandemic new normal situation?

The various replies of the participants are thematic into three groups and represented in the chart below.

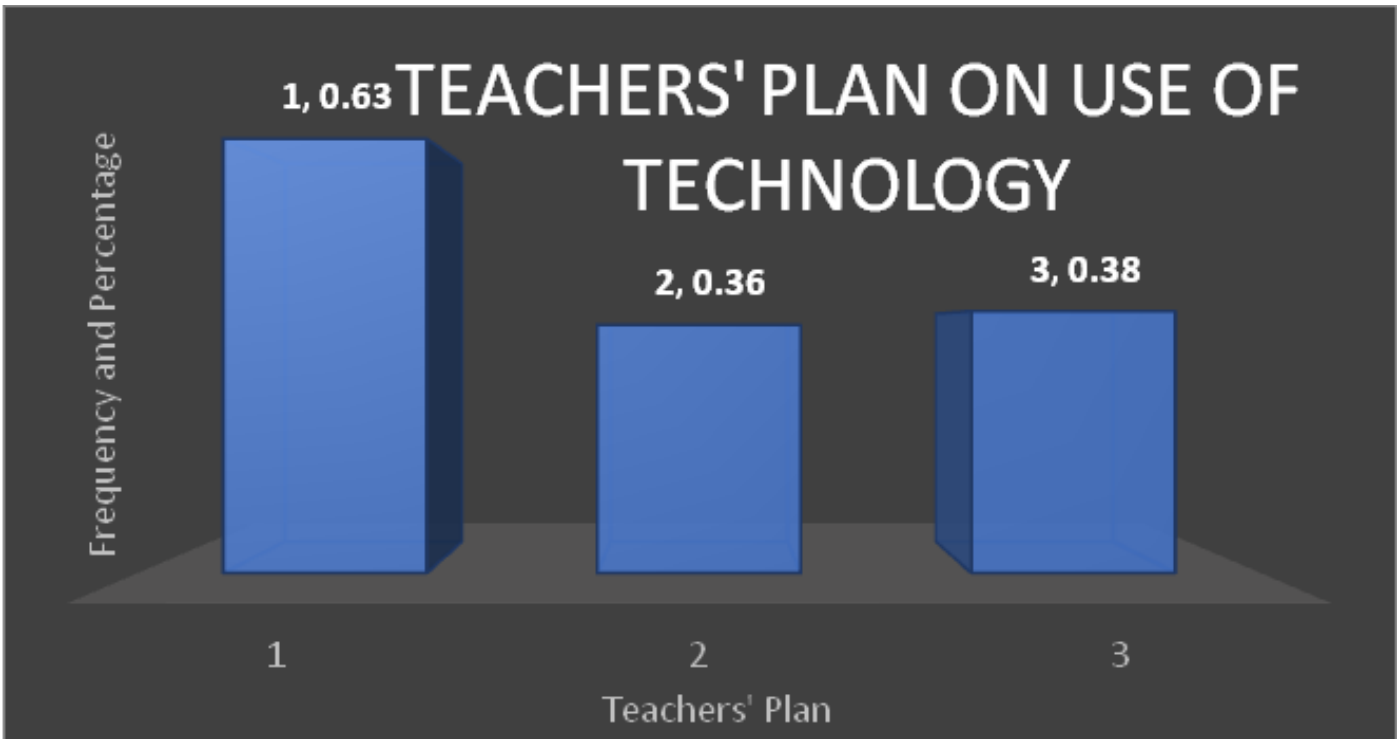

Figure 3: Teachers' plan on use technology

KEY: 1 – No; 2 – Yes; 3 – Not Sure

In response to science teachers plan to utilize technology in teaching, 126 (63%) of the participants do not have the intention to use technology, 18 (36%) plan to use technology while 19 (38%) teachers are not sure of their plans.

Research Question Four: What teaching methods do teachers plan to use in teaching science in the post covid-19 pandemic?

The responses are represented with the chart below:

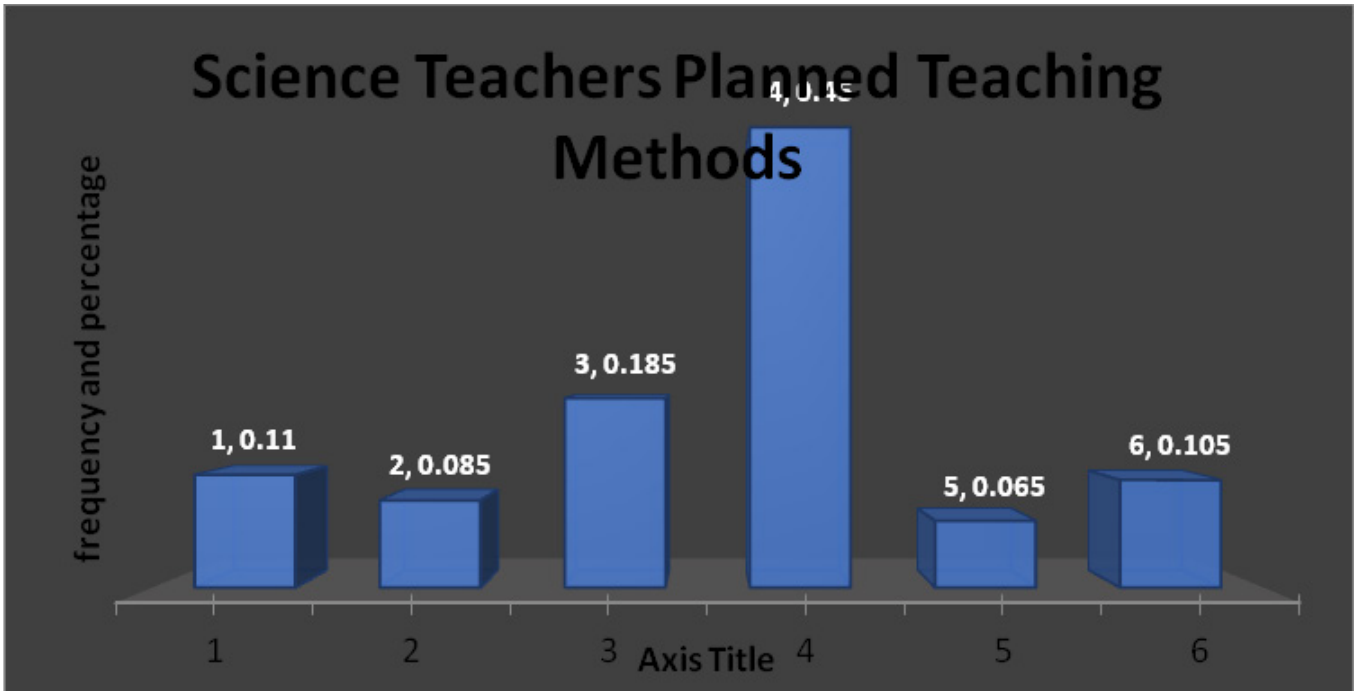

Figure 4: Teachers' methods of teaching science in post Covid-19 pandemic

KEY: 1 – Discovery; 2 – Discussion; 3 – Demonstration; 4 – Lecture; 5 - Laboratory; 6 - Project

Figure 4 above shows the responses of teaching methods teachers plan to use in the post Covid-19 pandemic. The graph revealed that 22 (11%) teachers plan to use discovery method, 17 (8.50%) teachers to use discussion, 37 (18.50) teachers prefer to use demonstration, 90 (45%) teachers to use lecture method, 13 (6.50%) teachers to use laboratory method and 21 (10.5%) teachers planned to use project method. The implication of this result is that more science teachers still planned to use the traditional lecture method.

Conclusion

From the result of the study, it is evident that most science teachers are not aware of the effect of the pandemic on teaching and learning. More science teacher plan to use the traditional lecture method than other methods. The result only shows the intended approaches that aimed to prevent physical contacts during teaching in classroom but failed to prepare new teaching approaches and methods that will enhance learning of science. In a pandemic situation like Covid-19 which no one is aware of its ending time, science teachers are expected to update and be current in pedagogical knowledge of teaching science to avoid traditional approach to teaching that do not integrate Covid-19 protocols. This will ensure continuous learning of science in the post pandemic.

Discussion

The result of the study showed some challenges of teaching science in secondary school in the post Covid-19 pandemics as viewed by science teachers. The challenges identified include limitation in the choice or selection of teaching strategies, shortage of instructional materials and resources for the teaching of practical as well as increased workload of teaching as a result of lack of classroom space.

These findings corroborate earlier findings of Osuafor & Okoli (2010) who reported lack of human and material resources in the teaching and learning of basic sciences such as biology, chemistry and physics. Nwachukwu (2012), also reported earlier that methods of teaching, evaluation process and lack of resources are serious problems facing teaching and learning of science in secondary school.

The pandemic has exposed and increase the challenges in teaching and learning science in Nigeria with the increase in number and intensity of the problems in post pandemic situation. When materials and resources had not been enough for teaching and learning, a situation where students will be spread over many classrooms in order to observe social distancing will require utilization of more resources such as instructional materials, teachers and other humans, laboratories, space, etc. Inadequate availability of these resources will pose serious challenges in the teaching and learning of sciences.

Considering the importance of science to the development of a nation, it must be effectively communicated for meaningful learning. To this end, there should be assurance of the provision of appropriate human and material resources for effective communication of science which will enrich learning experiences of learners. Aina & Abdurahman (2020) recommended that one way of surmounting the impact of Covid-19 is to adopt e-learning. This is the use of technology, i.e computer and internet, in teaching.

In spite of the global level of development of technology, the result revealed that most science teachers do not plan to utilize computer technology in the teaching of science in post Covid-19 pandemic situations. This is evident from the submission of Arubayi (2015) that science teachers mainly use traditional approach to teaching. Many reasons must have been attributed to this. It may be that many science teachers do not know how to utilize technology in the teaching of science, because they were not trained on how to incorporate it in the process of teaching science.

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Evaluation of Implementation of Google Classroom on Science, Technology, Engineering and Mathematics Subjects by Secondary School Teachers in Nandi County, Kenya

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Abstract

The Covid-19 pandemic is an unprecedented global crisis, affecting human health and economic welfare across the globe. The pandemic has resulted in economic slowdown, affecting education, trade, investments, growth and employment. Learning institutions were closed down in Kenya in March 2020. Various efforts have been put in place by the Ministry of Education (MoE) to ensure that learning goes on, particularly online learning. Secondary School teachers of Mathematics and Sciences were trained by Center for Mathematics, Science, and Technology Education in Africa (CEMASTEA) and MoE on the use of Google classroom in teaching and learning. The purpose of this study therefore was to evaluate the implementation of Google classroom on Science, Technology, Engineering and Mathematics (STEM) subjects by Secondary School teachers in Nandi County. The objectives of the evaluation were to establish: the extent of development and implementation of Google classroom by teachers and to establish the challenges faced by teachers in the use of Google classroom in teaching STEM subjects in Nandi County. This study employed Concurrent Mixed Evaluation Design where Causal comparative Ex-post Facto design was used to conduct the quantitative study and Phenomenological design was used to conduct the qualitative study. The target population of the study was 234 teachers who were trained during the 2020 INSET and 36 trainers together with the County Trainers representative. The subject representatives among the trainers gave reports during an online Google meet organized on the progress of the development of Google classroom and its use by the various subject teachers. Teachers too were given the opportunity to give their views. An interview schedule and a document analysis guide were used to collect quantitative data and qualitative data respectively. Piloting of the instruments was done to validate them. Test-retest method was used to test for the reliability of the evaluation instrument. Qualitative data from the document analysis guide was coded into themes and categories. Data from the interview schedule was analyzed using descriptive and inferential statistics. It was found out that 88 % of the teachers were able to develop the Google classroom. The content areas developed by the teachers in their Google classroom include; lesson notes, questions/assignments, animations and photographs, among others. Some of the teachers were able to invite the learners and their teacher colleagues to their classrooms. Some of the learners too were reported to have responded in each subject, to the tasks given by their teachers. Google meet being a component of the Google classroom was also found to have been used by a few teachers as reported by the subject representatives. The challenges faced by teachers in the use of Google classroom in teaching are; insufficient ICT infrastructure, poor network in some areas and also lack of electricity. Reaching learners was also found to be a major challenge faced by teachers in using Google classroom. Low ICT knowledge among some teachers and students is also a challenge. From the hypothesis tested, the study findings indicate that the number of teachers who developed Google classroom in STEM subjects vary significantly. The findings of the evaluation will inform CEMASTEA, Ministry of Education and teachers on the extent of the achievement of objectives set in the use of Google classroom in teaching and learning of STEM subjects during Covid-19 pandemic.

Keywords: *Implementation, Google Classroom, Teachers*

Introduction

This study sought to evaluate implementation of Google Classroom on Science, Technology, Engineering and Mathematics subjects by secondary school teachers in Nandi County, Kenya. Nandi County has six Sub Counties and is surrounded by the Nandi Escarpments. It is bordered by Uasin Gishu County form the North and East, Kakamega County from the West and Kisumu County from the South. Teachers in Nandi County were among the cohort trained nationally in June 2020 on the use of Google classroom in teaching. The extent of implementation on this programme attracted the evaluator.

Context of the evaluation

Science, Technology, Engineering and Mathematics (STEM)

STEM is an acronym that stands for science, technology, engineering, and mathematics. According to the report from the director of Center for Mathematics, Science, and Technology Education in Africa (CEMASTEA) in 2017,

"*The Global Talent Competitiveness Index 2017 placed Kenya at sixth position in Africa behind Mauritius, Botswana, South Africa, Zambia and Rwanda. Globally, Kenya was ranked position 97 out 118 Countries. CEMASTEA, with support of the Ministry of Education (MoE), has embarked on a program to popularize STEM in basic education (primary and secondary) to bridge the gap between opportunities in the labour market and number of graduates in STEM related field. The main aim of introduction of STEM models schools is to nurture scientific, technological and mathematical talents as early as possible*".

Google Classroom and its use in STEM subjects

Google Classroom is part of the online Google Apps for Education (GAFE) that is used to conduct online learning, with applications for teachers and students in learning and online collaboration. This application is downloaded for free, but it must be placed at the level of educational institutions. Google Classroom helps teachers and students to communicate and can be used to organize and manage assignments, to go paperless, for collaboration between students and between teachers, for teaching from a distance, and so on. As the classroom is becoming more and more paperless, teachers have to start finding solutions to hand out assignments, manage their classroom, and communicate with students.

Google classroom is a Learning Management System (LMS) offered by Google for teachers. This application provides a central location to communicate with students, ask questions, and do assignments. In an increasingly digital world, Google classroom helps facilitate online learning for digital learners today. Similar to many new applications, Google classroom comes with a unique look and feel. Because of this method, the teacher organizes classrooms uniquely as teaching methods

Google Classroom enables users (teachers) to create an online classroom area in which they can manage all the documents that their students need. Teachers can quickly see who has or has not completed homework, and provide direct, real-time feedback and grades right in the classroom.

One of the best features of the Google Classroom is that it is integrated with other Google services like Gmail, Google Docs, Driver, Sheets, and so on. Users need to download the app of Play Store or App Store, and log in. First, the teacher creates a unique class for every lesson that they teach. You then can be able to add students to your class manually or they can join your class on their own through their own Google account, using a given class code.

According to Tedor & Ebert (2017), STEM is the ability to identify, apply, and integrate concepts from science, technology, engineering, and mathematics to understand complex problems and to innovate to solve them. It therefore involves conceptualizing the problem and relating to science and mathematics and coming up with the solutions. Online teaching should therefore be embraced in STEM subjects by teachers. The used of Google classroom can be employed by teachers during the Covid-19 period and after.

STEM model schools motivate and inspires students to excel in STEM subjects and pursue STEM related courses in their future careers. These courses will help address the existing need for workers in STEM related careers (CEMASTEA, 2017). The report further indicates that “the new education curriculum also proposes STEM as one of the pathways for learners. Therefore, there is need for teachers and other educators to build capacity on interdisciplinary approach to instruction in STEM both for existing curriculum and the reformed curriculum”.

STEM subjects (Mathematics, Physics, Chemistry and Biology) should therefore be taught as one as a multidisciplinary approach where the teacher in each of the four subjects should bring the skills of the other three subjects in explaining phenomena. The features of a Google classroom enable teachers to use multidisciplinary approaches to merge related ideas and teach as one.

Purpose of the Evaluation

The World Health Organization has declared Covid-19 as a pandemic that has posed a contemporary threat to humanity (WHO, 2020). This pandemic has paralyzed all operations in different countries. Schools were closed in Kenya in mid of March 2020 because of Covid-19 and students have been at home for over six months.

Learning shifted from face to face to online ways despite the various technological challenges faced by students and parents as they try interacting with the content from Ministry and also from their schools.

CEMASTEA and Ministry of Education conducted an online training, beginning June 2020 in all Counties, to train selected Mathematics and Science teachers on the use of Google classroom in teaching during Covid-19 pandemic. Several teachers were trained in all counties on the use of Google classroom. The set of trained teachers were to own the programme, induct their colleagues and begin teaching their learners online. This evaluation therefore focused on the extent of achievement of the set objectives of Google classroom and its applications among Secondary School teachers in Nandi County.

Teacher Development Courses (TPD) in Kenya

Center for Mathematics, Science, and Technology Education in Africa (CEMASTEA) has been conducting professional development courses to science and mathematics teachers to improve on their methodologies with the aim of improving their attitudes and that of the learners. The courses conducted by CEMASTEA encourage the teachers to shift the teaching approaches from teacher-centered to learner-centered pedagogies.

STEM is part of the Applied Learning Programme (ALP) that the Singapore Ministry of Education (MOE) has been promoting since 2013, and currently, all secondary schools have such a programme. It is expected that by 2023, all primary schools in Singapore will have an ALP (MOE, 2016).

According to Moore, Roehrig, Lesh, and Guzey, (2010), "In order to prepare students to address the problems of our society, it is necessary to provide students with opportunities to understand the problems through rich, engaging, and powerful experiences that integrate the disciplines of STEM" (p. 4).Separating the disciplines sets up artificial divides that are not generally present outside of the classroom, while integration presents the disciplines in a more honest or realistic fashion.

Online learning

Online learning is defined as "learning experiences in synchronous or asynchronous environments using different devices (e.g., mobile phones, laptops, etc.) with internet access (Singh & Thurman, 2019). Students can be anywhere to learn and interact with instructors and other students during the online sessions. Hrastinski (2008) stated that the two types of online learning, namely asynchronous and synchronous online learning, are majorly compared but for online learning to be effective and efficient, instructors, organizations and institutions must have comprehensive understanding of the benefits and limitations.

Digital transformation in the context of higher education institutions can be regarded as the summation of all digital processes required to accomplish transformation process that gives higher education institutions the opportunities to positively apply digital technologies optimally (Kopp, Groblinger & Adams, 2019). This process also consists of adequate strategic preparation, trust establishment, thinking in processes, amalgamation and reinforcement of all parties involved, separate, collaborative and organizational knowledge (Cameron & Green, 2019). Digital transformation in teaching and learning was adopted in Kenya, short while after the schools' closure. This enabled instructors to continue teaching during the Covid-19 pandemic.

Joshi, Chapagain & Kharel (2020) concluded in their study that the instructional achievement of online learning is debatable because it causes absence of face-to-face relationship among learners and instructors. The students attend the lessons at any place wherever they are, and the instructor too is at any place. Hodges et al. (2020) differentiated adequately planned online learning experiences from courses presented online as response to crisis. These researchers went further to refer to online education during this pandemic as "emergency remote teaching" because the latter is in contrast with quality or effective online learning. Most of the learning institutions were closed and hence learning was interrupted. This necessitated the shift to online learning. Effective online education consists of effective online teaching and learning (Hodges et al., 2020; Bozkurt & Sharma, 2020).

Notable challenges in online learning are that Instant feedback and immediate response are not possible (Littlefield, 2018). This is due to the fact that both the instructor and learners are not together in one venue. Also, there is a low-level preparedness among the students concerning the usage of Learning Management Systems (Parkes, Stein & Reading, 2014). This is due to low skills on computer use, among other challenges.

Significance of the evaluation

The findings of this study shall inform CEMASTEA and MoE on the extent of the use of Google classroom among teachers in Nandi County. Teachers too will benefit from the study findings on the practice and use of Google classroom with the associated challenges in teaching and learning of STEM subjects.

Research gap

The above literature reviewed describes online learning and its application in STEM subjects. None of the literature has evaluated a programme on online learning and this study therefore aims to evaluate the extent of implementation of Google classroom as used in online teaching and learning among Science and Mathematics teachers in Nandi County.

Theoretical Framework

The ideas in the Social learning theories of John Dewey, Zoltan Dienes, and Richard Lesh guided this evaluation. These theorists have influenced STEM classrooms for a long time. According to Glancy, Aran and Moore, Tamara (2013), experiential education, concrete manipulative, and multiple representations are just some of the lasting ideas taken in part from these theorists that remain important components of current educational practice. Teachers of STEM subjects should therefore use the ideas of these theorists in different ways. Glancy et al. (2013) further observe that "As integrated approaches to science, technology, engineering, and mathematics (STEM) become more common, the need to develop effective strategies in these cross-disciplinary environments becomes more urgent".

According to Moore, Roehrig, Lesh, and Guzey (2010), in order to prepare students to address the problems of our society, it is necessary to provide students with opportunities to understand the problems through rich, engaging, and powerful experiences that integrate the disciplines of STEM.

Lesh and Dewey agree that students' problems in schools should be grounded in the real world, but all they believed students should work collaboratively (Glancy et. al, 2013). These two theorists have different views. For Dewey (1916, 1938) education was both social in nature and served a function within a democracy, thus students should act and be treated like members of a community with all the freedoms of the members of a democratic society. The pursuits Dewey envisioned for his students were community pursuits, requiring the students to work together as a community of learners (Glancy et. al, 2013).

According to Lesh, realistic, interdisciplinary problems outside of school are usually tackled by teams, often where members have different areas of expertise. Because of this, it is logical for students to also approach their problems in teams. Students also share experiences in teams rather than individual basis.

Evaluation Model

This study was guided by Ralph Tyler's Objective Model. The purpose of Objectives Oriented Evaluation is to determine the extent to which objectives of a programme have been achieved.

Steps in Tyler's Objective model

The evaluator specifies programme objectives and then collects and analyses pertinent data to determine how well each of the objectives have been achieved. Tyler's objective model assesses whether behavioural objectives are being achieved. To Tyler, behaviorally stated objectives are established then relevant student behavior measured against these objectives. The purpose of evaluation is to determine the extent to which the objectives of a programme are actually being realized.

This evaluation focused on the extent of achievement of the set objectives of Google classroom and its applications among teachers in Nandi County. The objectives evaluated were that teachers were: to develop Google classroom with content suitable for teaching and learning as per KCSE syllabus and to design innovative teaching and learning resources and activities.

The following two objectives of Google classroom were evaluated:

Teachers were to: Develop Google classroom with content suitable for teaching and learning as per the KCSE syllabus; Design innovative teaching and learning resources and activities

Evaluation Design and Methodology

This study employed Concurrent Mixed Evaluation Design where Causal comparative Ex-post Facto design was used to conduct the quantitative study and Phenomenological design was used to conduct the qualitative study. These designs fitted this evaluation as information concerning the implementation of Google classroom and related features with their applications were evaluated.

Target population

The target population of the study was 234 teachers who were trained during the 2020 INSET and 36 trainers together with the County Trainers Representative. These respondents possess the information of interest by the evaluator.

Sample and Sampling Procedures

All teachers were put into four strata according to the subjects they trained (Mathematics, Physics, Chemistry and Biology). The subject representative from each subject was purposively selected to report on the findings.

Evaluation Instruments

A document analysis guide was used to collect qualitative data while an interview schedule was used to collect quantitative data. Each of these instruments had question items soliciting information from all the required aspects.

Validity of the Instruments

A research and evaluation expert were requested to validate the data collection instruments. Piloting of the instruments was also done with four teachers, one per subject, who were not to participate in the study.

Reliability of the Instruments

Test-retest method was used to test for the reliability of the interview schedule. It involved administering the evaluation instrument to four teachers and four trainers (who were not to participate in the study), the instrument was scored, and the same instrument was administered to the same group of subjects after a week and scored. The responses obtained in the two occasions were compared and Pearson's product moment correlation coefficients were calculated. A coefficient of 0.8 was obtained and hence acceptable according to Madan & Kensinger, (2017), who observe that a coefficient of at-least 0.7 is acceptable.

Data Collection Procedure

The subject representatives gave reports during an online meeting organized on the progress of the development of Google classroom and its use by the various subject teachers. Teachers too were given the opportunity to give their views. An interview schedule was used to collect quantitative data as the meeting was on while a document analysis guide was used to collect qualitative data from the County trainer's representative after the meeting.

Data Analysis Procedure

Qualitative data from the document analysis guide was coded into themes and categories. Quantitative data from the interview schedule was analyzed using descriptive and inferential statistics. Frequencies and percentages were calculated while Chi-square test was used to test the hypothesis. Data was then presented using tables.

Evaluation of the extent of development and implementation of Google classroom in STEM subjects by Secondary School teachers in Nandi County

This study sought to establish the extent of development of Google classroom among secondary school teachers in Nandi County. Table 1 shows the summary of the teachers who trained and those who were able to develop the Google classroom in the STEM subjects.

Table 1: Number of teachers who developed the Google classroom

Subject	Total number of teachers trained	Number of teachers who developed Google classroom	Percentage
Physics	42	42	100
Chemistry	52	47	90.3
Mathematics	72	58	80.5
Biology	68	59	86.8
Total	**234**	**206**	**88.0**

From the report given by Subject representatives during the Google meet organized, and as shown in table 1, 58 (80.5 %) teachers were able to develop Google classroom in Mathematics; 42 (100 %) in physics; 47 (90.3 %) in Chemistry and 59 (86.8%) in Biology were able to develop their Google classrooms. A total of 206 teachers translating to 88 % were therefore able to develop the Google classroom with the required features. The content areas developed by the teachers in their Google classrooms include; lesson notes, questions/assignments, animations, photographs among others. These findings indicate that most teachers are able to develop and use a Google classroom and hence improved on the quality of teaching-learning process. This finding agrees with that of Hodges et al., (2020); that effective online education consists of effective online teaching and learning.

Some of the teachers were able to invite learners and their teacher colleagues to their classrooms and they were able to teach using it. A few of the learners invited by teachers to their Google classroom were reported to have responded in each subject, to the tasks given by their teachers.

Google meet being a component of the Google classroom was also found to have been used by a few teachers as reported too by the subject representatives. This aspect therefore has not been fully utilized by majority of the teachers. Coverage of Practical or experimental areas were found to be challenging to most teachers, as reported in their groups leaders. They observed that it is hard to teach these areas via the use of Google classroom.

Challenges faced by teachers in the use of Google classroom in teaching STEM subjects in Nandi County

This study also sought to establish the challenges faced by teachers in teaching STEM subjects in Nandi County. From the reports given by the subject representatives during the Google meeting, it was established that ICT infrastructure was a challenge to most of the teachers especially laptops, desktops and Smart Phones.

Power was noted to be a problem in some areas and also network was a major challenge faced by most teachers and students as they interacted and used the Google classroom in teaching and learning.

Method of inviting learners to Google classroom was found to have been a major challenge experienced by teachers especially obtaining email addresses used by the learners. The teachers who were able to invite learners to their Google classrooms indicated also that the learners could not respond at all or some could respond late.

Low ICT knowledge was also found to be a challenge to most teachers and learners, especially in the use of various features of the Google classroom.

Test of hypothesis

One null hypothesis was tested using Chi-square method, at 0.05 level of significance.

H_0: Frequencies of development of Google classroom among Secondary school teachers in Nandi County is not the same.

H_1: Frequencies of development of Google classroom among Secondary school teachers in Nandi County is the same

Table 2: Frequencies of development of Google classroom among Secondary School teachers

Subject	**Number of teachers who developed Google classroom**
Mathematics	58
Physics	42
Chemistry	49
Biology	59
Total	**206**

Table 2 shows the frequencies of development of Google classroom in STEM subjects among secondary school teachers in Nandi County. Most teachers (59) in Biology were able to develop Google classroom while 58; 42 and 49 teachers were able to develop Google classroom in Mathematics, Physics and Chemistry respectively.

The results in table 2 were also used to test for the hypothesis as shown in Table 3.

Table 3: Results for Chi-square test at α = 0.05, and (4-1) = 3 degrees of freedom

Subject	**Observed frequencies (O)**	**Expected frequencies (E)**	**Chi-squares**
Mathematics	58	51.5	0.8203
Physics	42	51.5	1.752
Chemistry	49	51.5	0.1214
Biology	59	51.5	1.092
Total	**206**	**206**	**3.7857**

At α = 0.05, and (4-1) = 3 degrees of freedom, the critical value from Chi-square table is 7.81. As per table 3, the calculated value of Chi-square is 3.7857. Since 3.7857 < 7.81, we do not reject the null hypothesis, H_0 and conclude that frequencies of development of Google classroom among Secondary school teachers in Nandi County is not the same. This means that there is no relationship between the frequencies of development of Google classrooms in STEM

subjects among Secondary School teachers in Nandi County, indicating that the number of teachers who developed Google classroom in each STEM subject in Nandi County vary subject-wise. This is also evident from the raw scores showing the number of teachers who developed Google classroom as shown in table 2.

Conclusion

From the study findings, it is evident that training teachers on Google classroom and its application in teaching STEM subjects was effectively done as majority of the teachers (88 %) were able to come up with Google classrooms. Teachers to were able to come up with learning activities ranging from assignments, questions, notes and animations they used to teach though most of the learners have not been reached by their teachers because of missing contacts in form of emails. Teachers are able to teach STEM subjects with the aid of Google classroom as noted.

The challenges faced by teachers and learners in the use of Google classroom in teaching and learning are; insufficient ICT infrastructure, poor network in some areas and also lack of power. Reaching learners was also found to be a major challenge faced by teachers making the use of Google classroom difficult. Low ICT knowledge among some teachers and students is also a challenge. From the hypothesis tested, the study findings indicate that the number of teachers who developed Google classroom in the STEM subjects vary significantly.

From the study findings, it is recommended as follows; The concerned ministries in Kenya should ensure that the entire Nation has electricity and networked to ensure that online learning and teaching can be fully effective. Also, all learners in all secondary schools should develop email addresses and it should be mandatory for a learner joining form one every year to have an email address. This will enable online learning to be fully effective with the use of emails rather than class codes

ICT infrastructure should be availed in all secondary schools and a computer room is necessary in all these schools. KICD should also review the curriculum and come up with basic computer knowledge e.g. Ms-word, Ms-Excel and Power point for teachers and learners to interact with them and hence improve on their ICT knowledge that may be required to be applied elsewhere.

A related study shall be conducted by the evaluator in December to test hypothesis on the enrollment rates of students to Google classroom among secondary school teachers in Nandi County and also to test the hypothesis on performance of male and female teachers as measured from their overall assessment scores obtained in the development and use of Google classroom in teaching and learning.

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Covid-19 and Nature: The Interconnections

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Abstract

Covid-19 is a worldwide pandemic that is impacting on a whole range of humanity and its activities. The origin of this body impairing infectious disease and the devastation it has brought along its way evidently shows the interconnectivity of the global community. The role of nature (land, air and sea), its diversity and natures' potential to offer solutions and inform policy decisions that may lead to resilience and adaptive capacity of humanity cannot be underplayed. Climate change as a result of increase in greenhouse gases (GHGs) has been linked to man's activities against nature and features as a key driver to the outbreak and spread of this pandemic. This paper looked through literature, media reports, anecdotal evidence and preliminary quantitative assessments provided by many actors. The actors included government, non-governmental organizations, international organizations, researchers and communities in various sectors that play important roles in man's development and that have been impacted upon either negatively or positively by the pandemic. These include education, biodiversity (terrestrial and marine), economy, forestry, wildlife conservation, tourism, agriculture, water, energy, transport, and research. Global carbon emissions are set to reduce in the short-term while human mobility has been reduced improving air quality. A decrease of the world's GDP due to the imminent economic recession might generate a reduction in the global CO_2 emissions in a similar proportion. This has encouraged more use of green spaces for recreation, sports and health promotion. Artificial Intelligence (AI) has found a new role in designing strategies to combat the pandemic hence digitalization and internationalization of many actions besides medical interventions. Digital poverty has come to light not least in learning institutions in developing and least developed countries where they are unable to take advantage of. These include, Massive Open Online Courses, Webinars, on-line workshops or conferences that require basic internet connectivity. Digitalization has increased as the concept of 'social distancing' and functioning remotely has become the new normal. Innovative Climate change learning could help communities design adaptive measures to cope with the disaster. Man's health has been the single most determinant to many actions that that have been prescribed to counter negative effects of Covid-19 including partial and total lockdowns that have spiraled wide-ranging impacts. Over a relatively short period since early 2020, studies on the impact of the pandemic have been published, though they have been largely focused on specific topics. The aim of this research was to compile these various impacts to better understand the bigger picture as these dramatic changes are interconnected to nature and our daily lives. The pandemic has and will continue to change the world in many ways. All agree that Covid-19 pandemic has just worsened the impacts of climate change. More research is on-going worldwide to quantify the impact of the pandemic and it is not possible to conclude which sector has been impacted more than the other as all are interconnected. The authors offer some insights on how the world is changing, and the conservation community that promotes environmental awareness and sustainability must be ready to respond.

Keywords: *Nature, Biodiversity, Climate Change, Covid-19, Artificial Intelligence*

Introduction

The Covid-19 pandemic is impacting negatively on all parts of human society. The world's population strives to have better education, healthcare, roads, agricultural systems and, above all, a better life. The importance of conservation and the implications of poor practices against nature cannot be gainsaid. There are inter-connections of industries and the importance of mainstreaming conservation into all sectors of the economy. Nature can act as our insurance policy against diseases like Covid-19 as the disease is partly a consequence of neglecting nature and thinking that human health and economic development are separate from it. It is healthy biodiversity and ecosystems that provide us with food, medicines, wood energy and water (UNCCD, 2020). Nature and conservation biologists are concerned first with how the pandemic will affect their families, friends, and people around the world. However, the onus is on us to think about how it will impact the world's biodiversity and our ability to protect it, as well as how it might affect the training and careers of conservation researchers and practitioners.

Colleagues, authors, and reviewers around the world have voiced the problems they are facing, and concerns for their students, staff, and research projects. The Covid-19 pandemic will have significant impacts on wildlife conservation, most of which will be assessed in the longer term. The most immediate of these impacts is the disruption of conservation funding, such as from wildlife tourism (Wildlife Direct, 2020). Some of the researchers have become infected with the virus and as a result, field and laboratory work has largely shut down; teaching and other communications have moved online; with consequences for training, data collection, and networking that are still unclear. Researchers and the media report some examples of reduced human pressures on natural ecosystems, cleaner air and water, and wildlife reclaiming contested habitats.

A growing body of research, points to a direct link between the destruction of nature and disease outbreaks and has put on the spotlight the role of protecting and restoring nature in preventing future pandemics (Conservation International, 2020). Beyond the direct and immediate consequences of this particular virus, there is a growing concern about emerging infectious diseases and their links with biodiversity loss, human activities, and issues of sustainability. Environmental agencies have reported an upsurge in deforestation during lockdowns, as well as increases in poaching, animal trafficking for food and illegal mining worldwide. The narrative of nature having been given a break during Covid-19, it is not entirely accurate. While it is accurate in cities and peri-urban areas in rural areas, the situation is almost the inverse (Sebastian, 2020).

Desertification, land degradation and drought (DLDD) often lead to the loss of animal habitat and the spread of diseases (including Covid-19) from animals to humans - known as zoonosis. A zoonosis is an infectious disease caused by a pathogen (an infectious agent, such as a bacterium, virus, parasite or prion) that has jumped from a non-human animal (usually a vertebrate) to a human (Merriam-Webster Dictionary,2019). Typically, the first infected human transmits the infectious agent to at least one other human, who, in turn, infects others (WHO, 2015). The rate of future zoonotic disease emergence or re-emergence will be closely linked to the evolution of the relationship between humans and the environment, particularly the expansion of the agricultural frontier (IPBES, 2018). The rapid expansion of agriculture and its disruption of wild ecosystems, combined with specific mechanized, genetic and agrochemical technologies have become a major force that has reshaped the biosphere. The vast monocultures that dominate 80% of the 1.5 billion hectares of arable land are one of the largest causes of global environmental changes. This has led to soil degradation, deforestation, depletion of freshwater resources and chemical contamination (Altieri & Nicholls, 2020). Recent estimates show that food production is responsible for up to 29% of global greenhouse gas emissions (Campbell et al. 2017). It is a paradox that technologies designed to improve livelihoods and feed people have also made the planet less hospitable to human life.

Long before the coronavirus pandemic, agroecologists had warned that industrial agriculture would become too narrow ecologically; be highly dependent on off-farm inputs; and extremely vulnerable to insect pests, diseases, and climate change (Altieri et al. 2015). As demonstrated by the Covid-19 pandemic, prone to a complete shut down by unforeseen crisis the Covid-19 has revealed how closely linked human, animal and ecological health are.

Kenya's Ministry of Tourism reduced national park entry fees by 50 per cent from 1st July 2020. This was to encourage residents to visit the parks at a time when foreign tourists could not go on safari in the country due to travel restrictions imposed as a result of the global coronavirus pandemic. In the Maasai Mara National Park and Reserve, on 400,000 acres of land with 49 tourist facilities earning up to 1.2b Kenya shillings per annum, about 700 million Kenyan shillings was reportedly lost by July 2020. Conversely, there are reported cases of reduced human-wildlife conflicts.

It is important to consider all stages of this Covid-19 crisis: prevention, preparedness, response and recovery (UNCCD, 2020). Similarly, conservation should be viewed as an investment that can create jobs, support livelihoods and reduce the costs of reacting to pandemics like Covid-19. African governments must recognise that conservation is an important pillar of economic development. They need to acknowledge that the livelihoods of rural communities are directly connected to nature, local food production systems and biomass energy.

At the Policy level on climate action, Africa Union (AU) Agenda 2063 ("The Africa we want") has a clear statement that Africa must have the means "to drive its own development, with sustainable and long-term stewardship of its resources and where Africa's unique natural endowments, its environment and ecosystems, including its wildlife and wild lands are healthy, valued and protected, with climate resilient economies and communities." On the Global stage due to the current health and safety measures put in place worldwide in response to the COVID-19 pandemic, COP 26 and subsidiary body sessions have been postponed to 2021.The 26th session of the Conference of the Parties (COP 26) to the UNFCCC was originally scheduled to take place from 9-19 November 2020, in Glasgow, UK. On 28th May 2020, the COP Bureau decided that it would take place from 1-12 November 2021, in Glasgow, UK. The change in dates had been anticipated following a decision, on 1 April 2020, to postpone the event due to the COVID-19 pandemic (UNFCCC, 2020). At that time, the COP Bureau announced that: *"In light of the on-going, worldwide effects of COVID-19, holding an ambitious, inclusive COP26 in November 2020 is no longer possible. Rescheduling will ensure all parties can focus on the issues to be discussed at this vital conference and allow more time for the necessary preparations to take place. We will continue to work with all involved to increase climate ambition, build resilience and lower emissions."* The pandemic is still accelerating in most countries and this paper can therefore only be a short review of a quickly evolving situation.

Methodology

This study was performed by purposively sampling and reviewing the available published literatures, case studies, and different government and non-government organizations information from reports and official websites. Scientific literatures were collected through electronic means from the database of Science Direct, Springer, PubMed, Taylor and Francis, Research Gate, and Google Scholar and UN-WHO, UN-FCCC, UNCCD sites but not in a systematic manner. From a large number of studies, this study compiles and presents the data and information which are relevant to the interconnections of COVID-19 with nature that includes biodiversity, natural resources, environment, economy, land and policy to meet the study goals.

COVID-19 and Biodiversity

The world is facing its sixth mass extinction event, with one million plant and animal species now threatened with extinction due to changes in land and sea-use, overexploitation, climate change, pollution and invasive alien species (Diaz et al., 2019[4]).Since 1970, populations of mammals, birds, reptiles, amphibians and fish have declined on average by 68% and vast areas of ecosystems have been degraded (WWF, 2020). Human destruction of biodiversity is one of the leading drivers of infectious disease outbreaks (Loh et al., 2015). It also poses a significant risk to supply chains, businesses and the global economy. RECCOMENDATION: Investing in activities that protect and restore biodiversity would provide immediate jobs, while also reducing the risk of future crises and improving the resilience and long-term viability of businesses and the economy.

Safeguarding biodiversity is vital to avoiding the next pandemic

Biodiversity and human infectious diseases are intricately linked. Zoonoses account for approximately 60% of all infectious diseases and 75% of emerging infectious diseases in humans (Taylor, Latham and Woolhouse, 2001). In addition to COVID-19, examples of emerging zoonotic diseases that have caused human health crises include Ebola, avian influenza, sudden acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS) and Human Immunodeficiency Virus (HIV). Human pressure on biodiversity increases the risk of infectious disease. Land-use change resulting from agricultural expansion, logging, infrastructure development and other human activities is the most common driver of infectious disease emergence, accounting for approximately one third of all emerging disease events (Loh et al., 2015). Wildlife exploitation (capture, hunting and trade) for human subsistence, recreation, medicine and ornamentation is another important driver (UNEP and ILRI, 2020). Scientists suspect that the SARS-COV-2 virus causing COVID-19 originated in bats and passed to humans via an intermediary host (possibly a species of pangolin or Civet) found in live-animal markets (MacKenzie and Smith, 2020; Wong et al., 2020; Zhang, Wu and Zhang, 2020).

A civet (/ˈsɪvɪt/) is a small, lean, mostly nocturnal mammal native to tropical Asia and Africa, especially the tropical forests. The best-known civet species is the African civet, Civettictis civetta, which historically has been the main species from which a musky scent used in perfumery was obtained. In 2002–03, civets sold for meat in local markets of China's Yunnan province carried the SARS virus from horseshoe bats to humans. The resulting viral outbreak killed 774 people in 2002–2003. [3]

The emergence of SARS in 2003 followed a similar pathway, but with traded masked palm civets as the intermediary host (Shi and Hu, 2008). Research through the Global Human Confinement Experiment (Amanda *et.al.,* 2020) is revealing a suite of effects on wildlife and ecosystems that are directly related to human activities (Corlett *et al.,* 2020; Rutz *et al.,* 2020; Pearson *et al.,* 2020). Many of these effects will be transient and vary across countries due to differences in how the lockdown was implemented and relaxed, and the associated socio-economic context. However, collectively these various scenarios offer a collection of diverse evidence for fundamental linkages between humans and nature, and where large-scale societal change can benefit biodiversity conservation.

Human confinement (Human Confinement: Fig. 1) has resulted in reduced air, land and water travel (Commuting: Fig. 1), with some initial effects on biodiversity being positive. For example, in many places manufacturing and commercial exploitation of natural resources such as fish and timber subsequently decreased. As a result, air and water quality improved as well as noise pollution declined (Muhammad et al., 2020; Zambrano-Monserrate et al., 2020). In some places, the exploitation of natural resources declined. Most notably, daily global CO2 emissions have abruptly decreased by 17% in the initial months of the lockdown (Le Quéré et al., 2020, Emissions: Fig. 1).

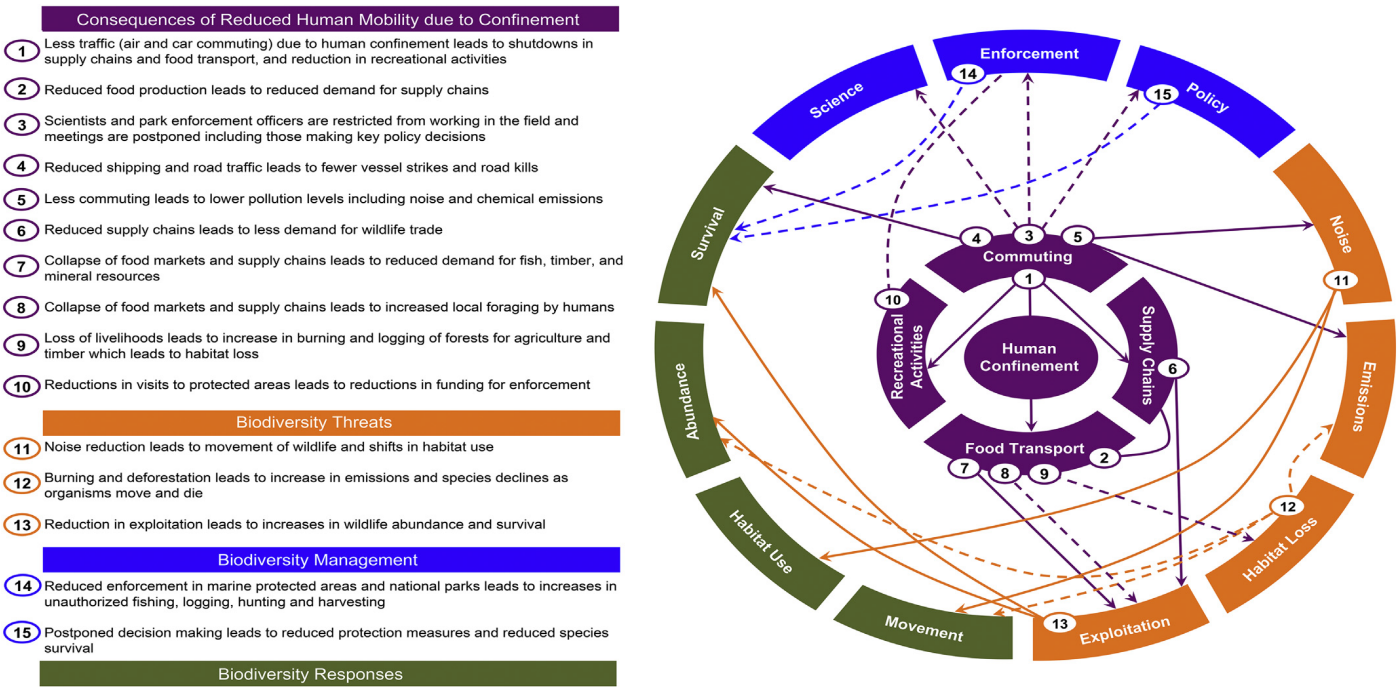

Figure 1. Emerging examples of cascading effects arising from the large-scale confinement of humans.
Source: Global Human Confinement Experiment

Effects are positive (solid line) or negative (dotted line) where color identifies the causal mechanism of the proposed change, and the arrowhead indicates directionality. Numbers identify examples (legend) of proposed interactions.
In effect, global warming has declined. Presumably, fewer animals are being killed by strikes, ships and vehicles on roads (Biodiversity Responses: Fig. 1). Sightings of animals in areas otherwise under heavy human influence, such as harbors and cities, have been attributed to lowered pollution (e.g., Noise: Fig. 1) and human activities in protected areas. A decline in manufacturing, the service and retail industries (Supply Chains: Fig. 1, e.g., Gray, 2020) and the production and transport of food (Food Transport: Fig. 1) have led to reductions (in some cases) in logging activity, wildlife trade and commercial fishing. Some conservation effects of the global human confinement may be transient and disappear soon after confinement relaxes, while others may be long-lasting (Casale and Heppell, 2016), such as strong recruitment success of long-lived, endangered marine species.

Lack of mobility has exacerbated unemployment and economic insecurity, which may explain reports in remote and rural areas of increasing wildlife foraging, illegal fishing, habitat conversion for agriculture, and other resource extraction activities that support livelihoods but also pose biodiversity threats (Fig. 1, e.g., Buckley, 2020). For example, in certain tropical areas of the world, increased cutting and burning of forests is reducing habitat (Habitat Loss: Fig. 1). In many places, decreased conservation enforcement because of the pandemic lockdown is facilitating poaching and illegal fishing (Buckley, 2020). Temporary declines in ecotourism to national parks and other protected areas (Recreational Activities: Fig. 1) may influence local revenue, park staffing and funding for anti-poaching and wildlife management programs (Buckley, 2020). In many areas, restoration projects have been postponed or may even be discontinued, which may result in a failure to reach conservation targets. Management programs to control pests may be suspended, leading to outbreaks. For example, the large-scale upsurge of desert locusts in the Greater Horn of Africa and Yemen are being attributed (in part) to the lockdown and the disruption of control efforts exacerbating food shortages for tens of millions of people and extensive environmental damage (FAO, 2020).

Reduced energy demands have led to an excess of oil, with a growing volume of oil held in supertankers in harbors in the USA and Singapore, increasing the risks of oil spills. The dramatic increase in the use of single-use gloves, masks, gowns, and other plastic materials, enhanced by the suspension of many government bans on single-use plastics, is creating a risk for a surge in plastic waste (Klemeš *et.al.,* 2020).

Unexpected outcomes are also arising as humans shift where they spend their time. Many national parks have seen dramatic declines in the number of visitors or in many cases have closed completely, and many urban parks were temporarily closed. However, other unregulated green spaces have experienced dramatic increases in visitation by people

living nearby with resulting environmental impacts, such as trampling of vegetation, erosion, widening of existing trails, and creating of new trails. There was a steep drop in CO2 emissions during the lockdown, but as the world returned to work, emissions rose and by June they were within 5% of the previous year. In the year 2020, the expectation is that emissions will fall 4-7%. While emissions can tell us, what is happening on the ground, it is the concentrations of these gases in the atmosphere that makes all the difference for global temperatures. Because CO2 can last for centuries, adding even a reduced amount to the air increases the warming potential of all the gas that has built up over decades (McGrath, 2020).

Environmental impacts of Covid-19

Covid-19 is affecting the lives of millions of people and, also, the environment. The CO2 emissions and human mobility have been reduced, which improves air quality and encourages wild animals to come out and explore the cities. But how sustainable the positive effect is in the long term is still debatable. Scientists have confirmed that air quality in certain regions has improved in recent weeks. As industries, aviation, and other means of transportation stop, air pollution is reduced in countries severely affected by the virus, such as China, Italy, and Spain. A reduction in commuting due to work from home policies has also played its part in reducing carbon emissions. According to Steven Davis, Associate Professor in the Department of Earth System Science at the University of California, in recent years, they have generated around 500 tons of CO2 per $1 million of the world's GDP. In 2019, 40 billion tons of CO2 were emitted per $88 billions of the world's GDP. If this correlation persists, a decrease of the world's GDP due to the imminent economic recession might generate a reduction in the global CO2 emissions in a similar proportion. Furthermore, Randolph Bell, Director of the Global Energy Center, explained in the Atlantic Council that the economic recession linked by the virus is likely to cause a drop in the carbon dioxide emissions for this year. He indicated that NASA's satellite images have evidenced the pollution reduction in China right after the carbon emissions had dropped by 25% in four weeks of lockdown.

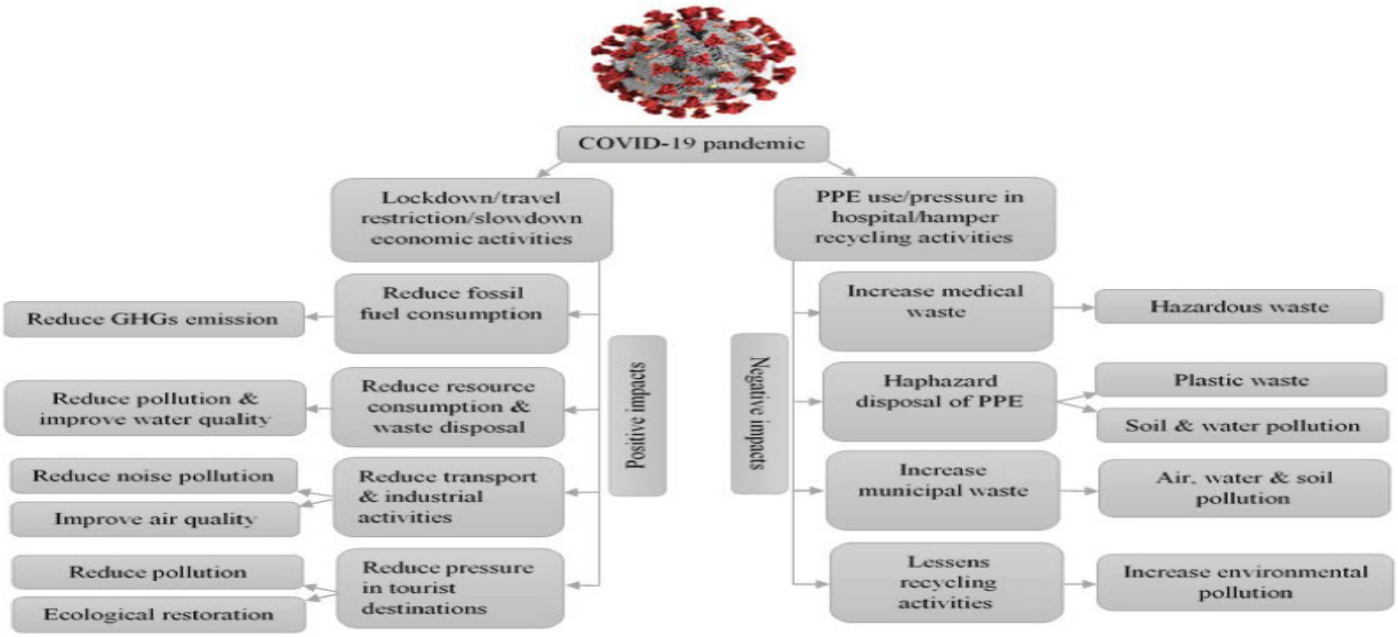

Figure 2: Positive and negative environmental effects of Covid-19 pandemic.

In the long term, the Covid-19 pandemic will offer lessons and opportunities leading to environmental action. For instance, we will have a new baseline of what can be achieved digitally: remote work, education, shopping, and more. In addition, as governments, private institutions, and even social media succeed in partnering, we will possibly feel more capable of tackling other pressing issues such as climate change. Our response to this health crisis will shape how we will deal with a climate crisis in the next decades. Times of change can lead to the introduction of long-lasting sustainable habits. Thanks to the outbreak, some habits that are incidentally beneficial to the environment may last since people will have experienced scarcity. For example, the reduction of travel, personal consumption, and food waste. This public health crisis may serve as a turning point for another well-known crisis that, even though it may be perceived as slow, has the potential of significantly impacting humanity. As the Secretary-General of the United Nations, António Guterres, indicated the threat of Covid-19 is

temporary, meanwhile, the threat of droughts, floods, and extreme storms linked to climate change will remain for years and will require constant action.

Clearly, human beings are part of nature and all activity that impacts the environment also impacts us. According to Marshall Burke from the Department of Earth System Science at Stanford University, in China, just two months of reduced pollution has saved the lives of 4000 children under the age of 5 and 73000 adults over the age of 70. Perhaps, this is not a question of whether the virus is "good" or "bad" for the climate, but instead if we can create a functional economic system that supports people without threatening the life of Earth. It is safe to say that no one wanted carbon emissions to be reduced this way. COVID-19 has a dark cost to our lives, healthcare systems, and mental health of people around the world. Nevertheless, it has also shown that communities can make a difference when they take care of each other, and this could be an invaluable lesson when we face climate change.

Covid-19 and Forests

Detailed data on the scale of the problem since lockdowns began is still being collected, but many natural resources management offices have been receiving almost daily reports of increased deforestation from around the world. Brazil and Colombia have seen an uptick in illegal logging and mining; the Philippines has also reported illegal logging and wildlife trafficking; Kenya has reported increased bush meat and ivory poaching, as well as increases in charcoal production, which has been illegal since 2018; Cambodia has seen an increase in poaching, illegal logging and mining; and similar reports have come from Venezuela and Madagascar.

Concerns have also been raised in Malaysia and Indonesia, which have the highest deforestation rates in South-east Asia, while in Ecuador, indigenous and afro-descendent communities have reported increased illegal mining in the Choco and Amazon rainforests. Troeng, 2020 states that there are two main factors that could be driving these trends. The first is criminal groups and opportunists expanding their activities, taking advantage of lockdown and diminished forest monitoring and government presence. The second is that people living in these rural areas are facing increased economic pressures and are forced to rely more heavily on nature for food and income. In some cases, such as Madagascar, Cambodia and Kenya, there has been a large urban-rural migration as people lose their jobs in the cities or return home to be with their families during quarantine, which has put extra pressure on local environments.

"What worries me is that we're seeing these emerging trends, and they're not going to be reversed when Covid measures are lifted because they're related to economic factors. So, my anticipation is that we're going to have to deal with this for potentially months and years," said Troeng.

Destruction of the rainforest will have severe ramifications and for indigenous and other communities who live there, it means a destruction of their way of life. This may lead to conflict with the people who encroach on their territory (Mwendwa *et al.,* 2020). Studies have also shown that destroying rainforest ecosystems raises the odds of new pathogens making the jump from animals to humans. It also harms our ability to deal with climate change, as tropical forests are a key component in absorbing carbon dioxide from the atmosphere.

Forest fires

Wildfire causes in Africa are mainly related to human activities (Wass 2000; Lambrechts *et. al.,* 2002; Detsch et al 2016); Fire is a key factor shaping the landscape and influencing vegetation structure (Dempewolf 2007) and composition (Detsch *et. al.,* 2016). Fire frequency, distribution, and severity are fundamental drivers of ecosystem dynamics (Tansey *et. al.,* 2004). Although many ecosystems are well adapted to recurring fire events, human activities and climate change have modified traditional fire regimes.

With a summit of 5,895 meters, or 19,341 feet, Mount Kilimanjaro is the highest point in Africa and is considered the highest free-standing volcanic mass in the world. The mountain's snow-capped peaks and the surrounding national park were declared a UNESCO World Heritage Site in 1987, with endemic plants and dozens of animal species, including endangered ones, calling it home. In recent years, the mountain and the surrounding ecosystem have faced challenges including water and air pollution, intrusion on the park's perimeters, illegal logging, and poaching. Climate change has also pushed the mountain's glaciers and icecaps to thaw.

Image 1: Rangers and volunteers trying to extinguish the flames on the Slopes of Mt. Kilimanjaro (Credit, New York Times-15th Nov. 2020)

In the year 2020 there were three (3) occurrences of devastating fires cutting through the most prestigious natural space in the whole of Tanzania. Already, vast areas of forest and low shrubs have been reduced to embers. Videos and images from the scene showed volunteers struggling to put out the fires as thick white smoke hung heavy in the sky behind them. The loss of plant life — particularly *Erica* and *Podocarpus* trees — could leave the area more vulnerable to fire in the coming years (New York Times-15th Nov. 2020). Strong winds and dry weather have hampered efforts to extinguish the spreading blaze on Africa's highest peak. Hemp, (2005) had reported that on Mt. Kilimanjaro, fires have been associated with large scale changes in vegetation, and in particular, a major loss in Ericaceous vegetation (heather and related species). Ericaceous vegetation generally occurs as a belt of vegetation just above the tree line. It was found that this belt had been reduced to 17% of its original area over the past 30 years (Hemp, 2005).

Image 2: Clouds of smoke from the fires on Mount Kilimanjaro, Africa's highest mountain, were visible from miles away. (Credit. Thomas Becker/picture alliance, via Getty Images)

Related studies show that Mt Kenya, fires in bushland and forest are common because community members use fire to burn charcoal, harvest honey, hunt in the forest, prepare farmland, break impenetrable bushland, and control weeds, pests, and parasites (Nyongesa and Vacik, 2018). What is critical is that the reporting of more fire incidents is due to the fact that forest patrolling regimes have been affected by low manpower and reduced monitoring missions during the COVID 19 pandemic.

Conservationists are concerned that the increased deforestation they are seeing in lockdown will lead to even bigger forest fires during Brazil's dry season than were seen last year. Forest fires in the Amazon generally occur during the dry season when people employ a slash and burn method to turn forest into agriculture land. In 2019, Brazil's forest fires increased by 84% compared with 2018. Smoke from the fires led to a public health alert, causing respiratory illnesses in people living in nearby cities.

Image 3: Besides harvesting of timber, land is deforested in the Amazon for cattle ranching and growing crops (Credit: Getty Images)

Many of Brazil's hospitals are already overloaded as they try to cope with cases of Covid-19. In early May, the country was declared the new global epicenter of coronavirus. Neighbouring Colombia has already seen an upsurge in forest fires in the first months of 2020. In March, the country registered 12,953 hot points – thermal anomalies that indicate higher risk of forest fire – in Colombia's Amazon rainforest, according to the Amazon Institute for Scientific Research, SINCHI. This is almost three times more than the 4,691 hot spots indicated last year during the same month. While hotspots don't necessarily turn into fires, they are a close indicator; scientists say 93% of registered hot points are later confirmed as forest fires.

Miguel Pacheco, natural resources and livelihoods coordinator with WWF-Colombia, says quarantine measures have not

been the cause of this increase in hotspots, but they could exacerbate the problem. Since Colombia went into lockdown in late March, monitoring flights by the armed forces that normally circle the region have significantly reduced. This could allow armed groups to take advantage of this lack of environmental control and continue to clear the area for cattle, coca plantation or other crops, as long as these quarantine measures persist, he says. Environmental authorities also reported an increase in illegal logging, wild animal trafficking and poaching of large cats since quarantine began, says Pacheco. In Colombia, lockdown poses the next in a long line of social changes that have fuelled deforestation. The destruction of rainforest has been a major concern since 2016, when the FARC guerrillas and the Colombian government signed a peace agreement. When the guerrillas demobilised from their holding areas in the jungle, it left the regions open to exploitation. In many areas, that meant armed groups and other organised crime cleared the forest for cattle and pasture land, particularly the Amazon states of Caqueta, Meta and Guaviare, some of the most affected.

Covid-19, Land and Agro-ecology

"healthy land; healthy people"

Land is the foundation for all life on Earth. How land is used and managed influences nature, food, water, energy, climate, and even our health. Today, the pressures on land and the wealth of resources it provides are greater than at any other time in human history. Nearly three quarters of the Earth's ice-free land has been transformed from its natural state. This is mainly to meet the demand for food, raw materials and human settlement (IPCC, 2019; IPBES, 2018). Even more alarming is the accelerated pace of land conversion, in order to provide the food, animal feed, fiber, bioenergy and water needed to achieve all Sustainable Development Goals (SDGs). Over the past 50 years, industrial production, technological development and our changing consumption patterns have significantly altered all ecosystems, putting over 1 million species at risk (IPBES, 2019). Land Degradation Neutrality (LDN) is a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase. LDN responds by considering land holistically so that the right things can be done in the right places at the right scale. LDN continues to provide a solid, streamlined system-wide approach to addressing DLDD while respecting national specificities. It allows communities to feel safe and secure on healthy and productive land.

The COVID-19 pandemic has highlighted the difficulty of meeting even our basic needs, in some places, in this time of crisis. People everywhere have suffered from lockdowns and have been impacted by supply chain disruptions. The agricultural labour force is buckling under the strain. The vulnerability of both our human and natural systems is laid bare. Healthy land plays a critical role in the supply of food and water and is also the source of employment for millions of people around the world. Land-use change, and wildlife exploitation increase disease risk by bringing people and domestic animal populations in close proximity to pathogen-carrying wildlife. Human pressure on ecosystems can also alter infectious disease dynamics by disrupting the species composition, function and structure of ecosystems (Karesh et al., 2012; Keesing et al., 2010; Halliday and Rohr, 2019) (Table 1). For example, when an ecosystem is disturbed its species diversity may decline while the abundance of "generalist" or "opportunistic" species increases. As these species tend to be effective zoonotic hosts, this can result in higher disease prevalence (Gibb et al., 2020).

Table 1. Possible mechanisms linking changes in biodiversity to infectious disease in humans

Level of diversity	Aspect of biodiversity undergoing change due to human pressure	Possible mechanism leading to human health effect
Genetic	Gene frequencies within populations of pathogens or hosts	Change in pathogen virulence or host resistance
Microbial	Composition of microbial communities in the external environment or within the host	Change in pathogen virulence in host immune response and allergic sensitization; expansion of range through human transport
Vector Species (living organisms that can transmit infectious pathogens between humans, or from animals to humans)	Abundance, diversity, composition and geographic range of vectors	Change in host-vector contact rates; change in contact between infected vectors and humans; expansion of range
Host Species	Diversity, composition and range of host species	Change in host-pathogen contact rates; change in competent host-vector contact rates; change in pathogen prevalence; expansion of range
Community (interacting species, including predators, prey/food, competitors)	Host density and contact with pathogen, host susceptibility to infection	Change in pathogen prevalence; change in human-pathogen contact rates
Ecosystem	Structure, complexity and diversity of vegetation; physical and chemical properties (e.g. climatic conditions)	Change in vector abundance and composition; change in host composition and distribution; change in host-pathogen contact rates; change in vector-host contact rates; change in infected vector-human contact rates; change in host-human contact rates

Source: Adapted from Pongsiri et al. (2009), Biodiversity Loss Affects Global Disease Ecology, *BioScience*, Vol 59 No. 11, pp 945-954 (2009)

In the case of multi-host pathogens higher species diversity may dilute pathogen transmission events, owing to the larger number of poor-quality hosts (i.e. the dilution effect) (Ostfeld and Keesing, 2012]). A recent study found that in areas under significant human use (e.g. agricultural and urban systems), wildlife hosts of human pathogens account for a greater share of total species abundance (21–144% higher) and species richness (18–72% higher) than in nearby undisturbed ecosystems (Gibb et al., 2020)

Land-based Solutions for Healthy People and a Healthy Planet

UNCCD underlines the importance of integrated land use planning that navigates trade-offs, takes account of the evolving urban-rural dynamic and encourages local, circular, production and consumption wherever possible. To further bolster the resilience of our basic food, water and employment systems, preparedness measures to reduce drought risk and vulnerability, gender-responsive land governance and an evolution of land use planning – to support Parties achieve land degradation neutrality (SDG15.3) and reduce risk – will continue as top priorities. The COVID-19 is a health crisis. It is also an economic and social crisis and response should be people-centred, prioritizing women, youth and the rural poor that often are the most vulnerable groups. The potential of land-based solutions is yet to be fully harnessed and intergovernmental decision-making processes are needed to establish innovative policies, norms and practical actions that build back better, smarter and stronger in the post-COVID19 context.

Humanity depends on land use practices which provide positive economic, welfare and security benefits. However, some forms of land use degrade ecosystems and adversely impact human wellbeing through the loss of biodiversity and ecosystem services (including food and water security) and the emission of almost a quarter of the greenhouse gases driving climate change. Moreover, land degradation elevates human health and safety risks, including the emergence of novel infectious diseases. This is because land use change frequently modifies natural habitats, expanding the wildlife-human interface while also altering the dynamics of inter-species microbial transmission (Gottdenker *et al.,* 2014). A recent comprehensive scientific review indicates that "commonly reported mechanisms by which land use change altered infectious disease transmission included alteration of the vector, host, and pathogen niche, changes in host and vector community composition, changes in behaviour or movement of vectors and/or hosts, altered spatial distribution of hosts and/or vectors, and socioeconomic factors, and environmental contamination" (Gottdenker *et al.,*2014). This in turn, increases the exposure of humans to pathogens and heightens the risk of spillover from wildlife to domestic animals and humans, known as zoonosis (Faust *et al.,* 2018, Morse *et al.,*2012). Land use change is the primary transmission pathway for emerging infectious diseases (EIDs) of humans, over 60% of which are zoonotic with most originating from wildlife reservoirs at the frontier clearings adjacent to natural ecosystems (Loh *et.al.,* 2015, WHO, 2014, Jones *et.al.,* 2013) The World Health Organization (WHO) estimates about one billion cases of illness and millions of deaths occur every year from zoonoses (WHO, 2014).

The enhancement of biodiversity is at the heart of the agroecological strategy. The idea is that agroecosystems should mimic the biodiversity levels and functioning of local ecosystems. Such agricultural mimics, like their natural models, can be productive,pest resistant and conservative of nutrients. This ecosystem-analog approach uses biodiversity to enhance agroecosystem function, allowing farms to sponsor their own soil fertility, plant health and sustained yields, therefore, eliminating totally the need for external agrochemical inputs or transgenic technologies. As a result of the biodiverse designs and absence of toxics, the opportunities for a variety of wildlife species to thrive are much greater (Altieri 2004). Many studies have demonstrated increased abundance of beneficial insects and more effective biological control in crops bordered by wild vegetation, from which natural enemies colonize adjacent crop fields (Marino and Landis 1996). Thus, under a landscape-level agroecological strategy, the preferred pattern is a complex matrix with fragments of forest separated by a variety of small farms (Perfecto,Vandermeer, and Wright 2009). In such environments, conservation is a product of the assemblage of productive agroecosystems rich in functional biodiversity (organisms that perform services for agriculture such as biological pest control, pollination, organic matter decomposition, etc.) . It also includes wildlife species, embedded in a complex ecological matrix creating 'ecological firebreaks' that may help contain pathogens from ecological release (Wallace 2020). This is crucial given that there are millions of viruses and bacteria that reside in wild animals and can potentially infect humans. These emerging diseases are on the rise everywhere as humans disrupt ecosystems and exploit animal habitats across the globe (Tobias & D'Angelo 2020).

Since late 2019, the world has been struggling to contain an outbreak of a new zoonotic virus commonly called Covid-19, and the repercussions have been colossal. Beyond the devastating public health crisis, the Covid-19 pandemic has evolved into a complex emergency with significant humanitarian, socio-economic, political and security dimensions. It has laid bare the vulnerability of both our human and natural systems, which were already threatened by climate change. On the economic front, recession and the contraction of per capita income is taking place in more countries simultaneously than at any other point since 1870 (World Bank. 2020). The pandemic poses a real challenge to the global goal of ending poverty by 2030 (SDG 1), which is now projected to increase for the first time since 1990 (UNU-WIDER, 2020). Poor, marginalized communities, without any support or safety net, are particularly vulnerable, and the number suffering from hunger could go from 135 million to more than 250 million people (FSIN, 2020). The agricultural labour force is buckling under the strain of the lockdown response to the pandemic and almost 1.6 billion informal economy workers are significantly impacted (ILO, 2020). The resilience of global systems in most sectors has taken a tremendous hit. This has led to dramatic swings in commodity markets and serious food supply chain disruptions (Reuters April 3, 2020) a sharp contraction in remittances—the largest source of foreign exchange earnings for emerging markets and developing countries, and even signs of reverse migration between countries and from urban back to rural areas. The pandemic-driven economic crisis itself brings impacts on human health that extend beyond the pandemic itself. As the number of coronavirus cases and deaths grow, disruptions in other healthcare areas have been significant, particularly for the most vulnerable. The ripple effects of the lockdown have rebounded upon already beleaguered health care systems in ways that will affect many who may have already weathered the coronavirus storm. For example, the developing world could witness 1.4 million excess tuberculosis deaths by 2025, while in sub-Saharan Africa over the next year, experts have predicted the possibility of 500,000 excess deaths due to AIDS-related illnesses 21 and 325,000 excess malaria deaths (WHO, 2020).

Impact of COVID19 and the economy

Global perspective

The COVID-19 pandemic is wreaking havoc in countries across the globe, causing a global health crisis and forcing economies to slow down due to the strict quarantine measures. As the pandemic spreads in different parts of the world, its consequences run farther than closed borders, scarce hand sanitizer, and social distancing protocols. The predications and concerns by the World Economic Forum on the effect of the pandemic are primarily economic (Figure 3.).This will cause countries to think more about sustainable globalization, international cooperation, integration, and economic growth (Bloomberg News, 2020). Many governments are currently developing or implementing stimulus measures and recovery plans to create jobs and drive economic recovery. Globally, stimulus measures announced to date are in the order of USD 10 trillion. A key challenge for governments is to ensure that the measures they introduce effectively address immediate social and economic needs, while promoting longer-term resilience, human health, well-being and sustainability. With this in mind, government and business leaders across the globe have called for a green and inclusive recovery to COVID-19. However, the focus of this rhetoric and the green stimulus measures introduced to date has largely been limited to climate change, with much less attention given to biodiversity. Biodiversity loss and climate change are challenges of a similar magnitude and urgency, and are fundamentally interlinked. They must be addressed together as part of broader efforts to achieve a green and inclusive recovery.

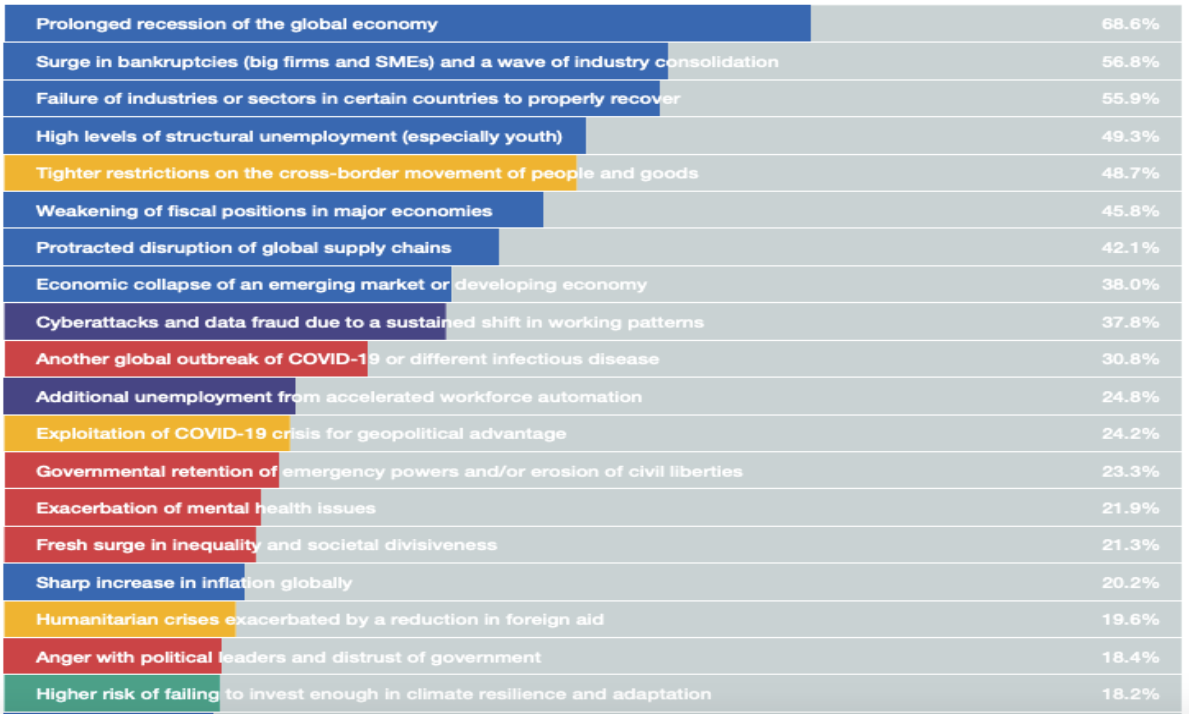

Figure 3: Predicted effects of coronavirus on the world. Source: World Economic Forum -WEF (Whiting, 2020)

Goldman estimates a decline in the economy of 35% in the second quarter of 2020 in rich countries. This is four times the decline of the financial crisis of 2008. It is not clear how the economy will recover (Clenfield, 2020). The International Monetary Fund (IMF) announced that this depression will be similar to The Great Depression in the 1930s. The IMF expects the global economy to shrink by 3% this year – far worse than its 0.1% dip in the Great Recession year of 2009 – before rebounding in 2021 with 5.8% growth. It acknowledges, though, that prospects for a rebound next year are clouded by uncertainty (Wiseman & Crutsinger, 2020). This new recession is called 'The Great Lockdown' (Greiff, 2020) and our vulnerability and co-dependence are now openly exposed (Gleiser,2020).

The Covid-19 pandemic has led to widespread human and economic losses. The global death toll surpassed 950 000 in September 2020, and continues to rise (Johns Hopkins, 2020]). Government-imposed lockdowns and other public health measures to protect citizens from the virus have led to an economic downturn of a gravity unseen since the 1930s depression. The OECD Economic Outlook Interim Report (September 2020) projects that global GDP will decline by 4.5% in 2020, followed by a gradual recovery with considerable heterogeneity across countries (OECD, 2020]). Unemployment is estimated to reach 9.4% by the end of 2020 in OECD countries and remain at 7.7% in 2021 (OECD, 2020).

Experts warn that worse pandemic will manifest if we do not start taking better care of nature. Pandemics like Covid-19 could occur more frequently unless we stop rapidly destroying nature, a group of biodiversity experts has warned. 1.7 million unidentified viruses, known to infect humans, are estimated to exist in mammals and water birds. Rampant deforestation, agricultural expansion, and infrastructure development bring us closer to catching them (Davidson, 2020). The global perspective linking nature to the economy is that there will be a green economic reset, and also a reset of work. The future will be greener and there will be a better balance between Planet, People, and Profit. To achieve and maintain this balance, the public sector will have to fulfill an essential role (Whiting, 2020).

Beyond sound risk management, integrating biodiversity into the Covid-19 recovery would offer economic and business opportunities. For example, it is estimated that the number of jobs created per USD 1 million invested in biodiversity restoration in the United States ranges from 7 for county-level wetland restoration to 40 for national-level forest, land and watershed restoration (BenDor *et. al.,* 2015). Restoring 15% of degraded ecosystems in the European Union would create an estimated 20 000 to 70 000 full-time jobs (Eftec *et. al.,* 2017). For businesses, opportunities come in the form of cost savings, new market opportunities (e.g. ecotourism, certified sustainable products), increased market share, and new businesses (e.g. ecosystem restoration). "Nature-positive" business opportunities could add up to USD 10.1 trillion in annual business value and 395 million jobs by 2030 (WEF, 2020).

Impact of Covid-19 on the Kenya economy

Since the first case of Covid-19 was reported in Kenya on March 13, 2020, the nation just like other countries in the world has been experiencing massive destruction of the economy in terms of GDP decline and job losses. While the country had started experiencing the economic impacts prior to Covid-19, the emergence of the virus accelerated Kenya's economic troubles. For the first time Kenya purchasing managers index slipped to 37.5 in March 2020 from 49 in February. This points to a sharp deterioration in business conditions that was the strongest since October 2017. However, the private sector is on its way to recovery going by the September purchasing managers index of 56.3. This depicts the biggest expansion in private sector activity since April 2018 as the government relaxed coronavirus restrictions. Data released by KNBS show that the output declined by 5.7 percent in quarter two report reflecting the impact of Covid-19pandemic. Sectors with the largest declines were accommodation and restaurants, transport and storage, education, manufacturing, wholesale and retail trade. Notably, despite the damages caused by Covid-19, agriculture reported a strong growth of 6.4%.

Sector Analysis

Manufacturing sector reported a contraction of 3.9 per cent in the second quarter of 2020 compared to an expansion of 4.0 per cent in the same period of 2019 largely contributed by effects of Covid-19. Manufacture of food which include beverages, meat and meat products among others recorded a contraction of 2.5 per cent during the review period. Tourism activities contracted by 83.3 per cent in the second quarter (March-June). This sector was the worst hit by the COVID -19 pandemic as businesses in accommodation and food services sector either operated under minimum capacity or completely closed down. The significantly reduced number of visitors' arrivals as well as restrictions of movement within the country adversely affected the sector's performance. In addition, the fear of contracting the virus by individuals led to people avoiding hotels and restaurant further affecting its performance negatively. The Kenyan coast has a vibrant tourism sector that has also been heavily affected by the pandemic. The latest statistics show that there were 2,048,834 foreign visitors to Kenya in 2019, compared with 2,025,206 in 2018. While these numbers were expected to rise in 2020, the sector is in lockdown, which has heavily disrupted the supply of seafood to the hotel industry, especially much-loved commercial species like lobster, prawn and snapper. This observation has clearly demonstrated the tight link between the tourism and fisheries sectors during the COVID-19 pandemic. Thus, it is now evident that in Kenya, a great part of the fishery economy is strongly linked to the vibrant tourism sector. Furthermore, in many instances, the fishers also engage in ecotourism activities by taking tourists fishing, diving or sampling local cuisines in local villages; these commercial activities have also been severely impacted.

The COVID-19 pandemic is an emerging driver over and above global climate change, which has been added to the list of risk factors influencing sustainable development and the exploitation of ocean resources. Due to the pandemic, curfews, partial lockdowns, the suspension of international flights and shipping, and restricted movements of people have severely interrupted not only the fisheries supply and demand chain but also the tourism sector. The situation has resulted in the near total collapse of livelihoods centred around fisheries, tourism and related economic activities. Transportation and storage sector are estimated to have contracted by 11.6 per cent in the second quarter of 2020 according to the second quarter GDP report released by KNBS. In the review period, restriction of movements resulted to significant decline in travel activities thereby impacting negatively the sector's performance. The volume of port throughput declined from 8,666.0 thousand metric tonnes in the second quarter of 2019 to 7,752.8 thousand metric tonnes in the review period. Freight

movement through Standard Gauge 4 Railway (SGR) rose by 3.9 per cent to stand at 1,053 thousand metric tonnes. This sector recorded a dramatic reduction in the number of visitor arrivals through Jomo Kenyatta International Airport (99.5%) and Moi International Airport (99.9%); mainly as a result of near cessation of international flights. The number of passengers by SGR declined to 6,363 in the review period from 408,931 recorded in the second quarter of 2019. Depression of activities of transportation and storage was reflected in declined consumption of light diesel, a major input to transportation activities, which contracted by 32.4%. Construction sector recorded a slowed growth of 3.9 per cent to June. However, cement consumption increased to 1,521.0 thousand metric tonnes in the second quarter of 2020. As the country continues to take a beating from COVID19, agricultural sector posted an impressive performance of 6.4 per cent from March to June from data provided by Kenya Bureau of Statistics in the second quarter of 2020.

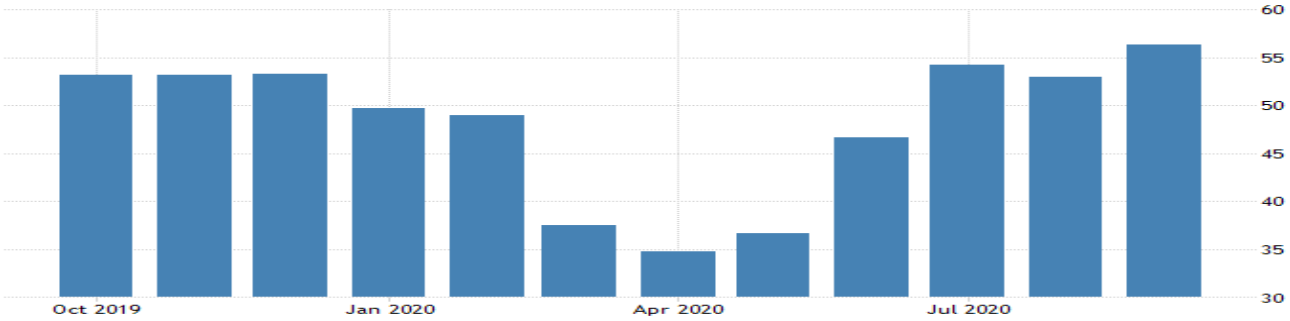

Fig. 4: Kenya's Purchasing index Source: Markit Economics

Covid-19 and Trade in Africa

In May 2019, the African Continental Free Trade Area (AfCFTA) came into effect, creating the world's largest free trade area and marking the single largest push to accelerate trade-led growth for regional integration and greater prosperity. At the continental level, the African Union's Agenda 2063 serves as a blueprint for transforming Africa into a global powerhouse of the future. More importantly, it signals the political will for a pan-African drive for unity, self-determination, freedom, and collective prosperity. For example, Rwanda has developed Rwanda Vision 2050, a bold plan to advance economic and social development and reach upper-middle-income status by 2035, and high-income status by 2050.

Climate change poses an existential threat to the global sustainable development agenda. Nowhere are the threats posed by climate change more pervasive, more pernicious, and more urgent than in sub-Saharan Africa, a region that contributes the least but stands to lose the most as greenhouse gas emissions accelerate. Absent forward-looking climate action, it is becoming increasingly clear that Africa's growth agenda and drive to achieve the Millennium Development Goals by 2030 will be in serious jeopardy. The past five years have been the hottest on record. The latest UN Environment Emissions Gap Report shows that greenhouse gas emissions have risen 1.5 per cent a year over the past decade. Global average levels of carbon dioxide reached 407.8 parts per million in 2018, setting another new record. `UN Secretary-General António Guterres has challenged countries, to "stop the war on nature" and warning that humanity stands at a "critical juncture in our collective efforts to limit dangerous global heating" (UN, 2020). Sub-Saharan Africa's ability to meet poverty reduction targets, feed a growing population that is expected to top 2 billion by 2050, tackle climate change, and secure long-term environmental sustainability depends on a vibrant agriculture and food sector. Most of the African continent's poor people live in rural areas, 70 per cent and more. The Africa Regional Overview of Food Security and Nutrition report says of the 257 million hungry people in Africa, 237 million are in sub-Saharan Africa and only 20 million in northern Africa.

Paradoxically, rural areas are where food is grown and yet they are the epicentres of hunger and poverty. Climate change is already exacerbating sub-Saharan Africa's food and nutrition security challenges, reducing both the quantity and quality of food. Studies by the World Bank and others show that without adaptation, Africa will suffer particularly severe yield declines by 2030, including in important maize growing areas such as southern Africa.

COVID-19 and BIODIVERSITY POLICY

How biodiversity is being factored into the Covid-19 recovery

Countries have introduced a range of policy measures to counter the impacts of the COVID-19 pandemic. While containing the virus and minimising its immediate impacts on human lives continues to be a priority.
any countries are also rolling out complementary measures to address the social and economic fallout of the pandemic. Covid-19 response measures to date span monetary policy (e.g. lowering or freezing of interest rates), regulatory policy (e.g. permitting and reporting requirements), fiscal policy (e.g. tax relief, subsidies, grants and loans) and other measures such as skills training. Globally, fiscal measures announced have already surpassed USD 10 trillion (Reuters, 2020), and this figure is expected to grow as more countries announce their recovery packages. While it is too soon to say conclusively what the net biodiversity impact of the Covid-19 recovery will be, this section provides an indication of current trends and highlights examples of how governments are integrating biodiversity into their stimulus packages and broader policy response to Covid-19 6

Effect Covid-19 policy responses on biodiversity

While some countries have taken steps to integrate measures beneficial to biodiversity in their policy packages, analyses to date suggest that spending on harmful activities may outweigh spending on beneficial ones. According to Vivid Economics' Green Stimulus Index, 17 major economies (OECD and G20 countries) 8 have announced economic stimulus packages that will direct approximately USD 3.5 trillion to sectors that can have a significant impact on nature – agriculture, energy, industry, transport and waste. In 14 out of the 17 economies, the volume of finance flowing to these sectors that is potentially harmful to biodiversity (e.g. bailouts for polluting companies without environmental conditions) outweighs financial flows to these sectors that is potentially beneficial (e.g. investments in ecosystem restoration). Of those countries assessed, France, Germany and the United Kingdom are the only three where potentially beneficial flows outweigh potentially harmful flows to these sectors (Vivid Economics, 2020). The G20 Energy Policy Tracker also indicates that harmful flows relating to energy outweigh beneficial flows. Since the beginning of the pandemic, the G20 has committed at least USD 382 billion to supporting different energy types. More than half of this (USD 206 billion) is directed to fossil fuels (IISD et al., 2020).

Perhaps the clearest example of a biodiversity-harmful response measure to date is the loosening of environmental regulation. Since the Covid-19 pandemic struck, some governments have weakened land-use policies, waste collection requirements, air and agricultural pollution standards, project permitting processes (including environmental impact assessment rules), and environmental monitoring and reporting requirements. Not all of these regulatory changes are permanent; however, even temporary changes could lead to an increase in biodiversity-harmful activities and set a dangerous precedent for rolling back hard-fought-for environmental regulations. In addition to weakening existing environmental regulation, some countries have postponed the entry-into-force of forthcoming environmental regulations.

Some fiscal policies introduced in response to Covid-19 may be harmful to biodiversity. The extent and nature of their impact will depend in part on the biodiversity footprint of the business/sector receiving the support (which can differ from one country to the next) and the volume of the stimulus and the design of the measure. A common example of a potentially harmful fiscal measure introduced to date is the issuance of loans, grants and guarantees without any environmental conditions, to bailout companies that have a heavy biodiversity footprint (e.g. airline and coal companies). Some countries have introduced subsidies potentially harmful to biodiversity (e.g. for fertiliser purchase), and temporarily waived or reduced biodiversity-relevant taxes (e.g. on oil/gas exploration and production), charges (e.g. on commercial operators in conservation areas) and fees (e.g. licencing fees for mining; protected area entrance fees). While waiving protected area entrance fees during the Covid-19 pandemic may be justifiable from a human health and well-being perspective, it is likely to have negative budgetary implications for biodiversity conservation.

Policy Brief on Biodiversity and Covid-19

This Policy Brief is as a result of literature review of recommendations of several published works around the world. It focuses on the vital role of biodiversity for human life and the importance of integrating biodiversity considerations into the recovery from the Covid-19 crisis. The Brief acknowledges that biodiversity loss is a key driver of emerging infectious diseases and poses a variety of other growing risks to businesses, society and the global economy. Investing in the conservation, sustainable use and restoration of biodiversity can help to address these risks, while providing jobs, business opportunities and other benefits to society. The Brief then examines how governments can factor biodiversity into their stimulus measures and recovery plans in practice, highlighting both concerning trends and best practices. The Brief concludes with policy recommendations on how governments can potentially integrate biodiversity into their Covid-19 stimulus measures and broader recovery efforts.

Key messages

Biodiversity underpins current and future human health, well-being and economic prosperity. Yet it is being destroyed at an unprecedented and accelerating rate, with 25% of all plant and animal species now threatened with extinction. It is therefore critical that countries integrate biodiversity considerations into their Covid-19 response and economic recovery plans.

Protecting biodiversity is vital for avoiding the next pandemic. Close to three-quarters of emerging infectious diseases in humans come from other animals. Land-use change, and wildlife exploitation increase infectious disease risk by bringing people and domestic animals in close proximity to pathogen-carrying wildlife, and by disrupting the ecological processes that keep diseases in check.

The economy and human well-being also depend on biodiversity for food, clean water, flood protection, erosion control, inspiration for innovation and much more. Over half the world's global domestic product is moderately or highly dependent on biodiversity. The ongoing decline of biodiversity therefore poses important risks to society. Investing in biodiversity as part of the Covid-19 policy response can help to minimise these risks, while providing immediate jobs and economic stimulus.

While government and business leaders have acknowledged the importance of a "green recovery", the focus has been predominantly on climate change. Yet biodiversity loss and climate change are challenges of a similar magnitude and urgency and are fundamentally interlinked. They must be addressed together as part of a broader green and inclusive recovery.

A number of countries have integrated biodiversity measures in their COVID-19 policy response. Examples of biodiversity measures include changes to regulation on wildlife trade to protect human health, and job programmes focussed on ecosystem restoration, sustainable forest management and invasive species control.

Despite some good practice examples, many countries have weakened environmental regulations or introduced stimulus measures that threaten to drive further biodiversity loss. Analyses suggest that the volume of potentially harmful spending committed as part of the economic recovery from the COVID-19 crisis outweighs the volume of spending beneficial to biodiversity.

Conclusions

Adapting education

Across the world, universities and research institutes have shut down. As with other subjects, courses critical to the training of conservation biologists and managers are being cancelled or moved online. In practice, this means that professors with little prior online teaching experience are now teaching students with little experience in online learning. This can work well for some topics, but conservation is an applied science, like medicine, and students will miss the practical, hands-on experiences gained through labs and field courses. The consequences will depend on how long the shut-down continues and whether practical components of their training can be postponed until later.

Many career-relevant decisions made in the field of conservation are affected by the COVID-19 pandemic. Exams have been postponed and the award of degrees and certificates has been delayed. There has been a huge decline in advertising new jobs and interviewing for those previously advertised. Major research projects are on hold or cancelled, and associated employment opportunities lost, at least for now. Many researchers are continuing to employ students and technicians to work remotely on data analysis, digitizing paper records, coding interview transcripts, annotating photos and videos, or other tasks, but this is only a small part of conservation-related research and cannot continue for long.

The careers of tenured staff will survive if their institutions do, and students may be able to make up missed courses, but conservation also supports—and is supported by—numerous people who depend on temporary jobs in the field or lab. Early career scientists, such as graduate students and post-docs, need these jobs, both as a source of income and for the varied experiences they provide. For these young conservation scientists, financial worries interact with the problem of missed field or lab research. For some, these missed opportunities can be made up, although they may lead to delays of many months, but for others the damage will be irreversible, because of the nature of their research or their funding constraints.

Many conservation organizations, both governmental and some NGOs, recruit large numbers of seasonal employees, as short-term local contractors, student interns, and volunteers, to carry out fieldwork, environmental education, trail maintenance, and other activities. These positions are an important source of training, experience, and income for people in the field of conservation biology. The pandemic currently makes it impossible for many organizations to interview, hire, train, house, and supervise seasonal staff. Unless lock-down measures are reduced dramatically in the next couple of months, a whole cohort of students may therefore miss out on these opportunities.

Delays in training and career development, in combination with the economic and psychological impacts of the COVID-19 pandemic, may cause some people to leave the field of conservation biology and pursue other careers that offer more stability or better pay. If the pandemic lasts into the next academic year, declining enrolments at universities, and in conservation and ecology courses, may have longer-term negative consequences. More optimistically, education and research in ecology, conservation, and environmental studies may appear more attractive and meaningful to young people who have been alerted to the global environmental crisis by this pandemic and made aware of the links between biodiversity conservation and human well-being.

Many Massive Open On-line Courses (MOOCs) have been launched. There are increased webinars and attending conferences, workshops and seminars have become the new normal and spanned a new way of doing business digitally.

Maintaining research

University laboratories and other research facilities have shut down, ending many lab-based experiments and halting new research. Field research has been similarly impacted, with many field sites no longer accessible, because of travel and entry restrictions, and safety concerns. International travel has become all but impossible, and post-pandemic recovery may be slow if countries maintain entry restrictions. Researchers can no longer conduct field-based social research that requires interviews or focus groups, because of the possibility of disease transmission. Oceanographic research cruises have also been cancelled, many permanently because of the difficulty of re-scheduling ship time. The impact of losing these expeditions is high, because the locations to be explored are typically remote and under-studied.

Missed research means missed opportunities to identify conservation priorities, monitor the health of endangered species and ecosystems, and provide practical solutions for the protection and sustainable use of resources on which human well-being depends. As with many concerns discussed here, the impact will depend on how long shutdowns last and whether research projects are simply postponed or permanently cancelled. Gaps in a long-running time series cannot be filled later but may not be serious if observations are restarted soon. A lot of conservation research nowadays involves data collection by citizen scientists. Most of this will be stopped for now, but it is important that conservation researchers keep in touch with citizen participants and, where possible, provide alternative activities. For example, backyard bird counts, and web-based projects may receive increased attention.

The looming global economic recession will reduce funds available to national governments and conservation foundations, and potentially reduce funding for research grants and conservation programs. Projects funded by the Inter-American development bank (IDB) and the Global Environment Facility (GEF), for example, are now requesting a formal risk analysis related to the pandemic to assess whether and by how much the projects they fund will be impacted by the virus. Conservation research is unlikely to be a government priority during the post-pandemic economic recovery, and conservation biologists must communicate the many benefits that both this research, and biodiversity itself, provide society. Organizations reliant on external donors to employ staff and implement research and conservation activities will be particularly vulnerable.

The knowledge generated by ocean science is important in understanding conservation actions aimed at safeguarding the environments that provide for the fisheries and tourism economy. We believe that the importance of science in understanding life under water can yield many positive results and lead to innovations in the coming days in the following areas:

1. Finding new ways of conducting marine research remotely using mobile apps to collect data that can be analysed by ocean scientists to provide information on the status of fisheries and the environment, as well as combat illegal, unreported and unregulated fishing, and increase security in the national marine space;

2. Developing innovations in habitat restorations that allow for experiential tourism for both local and international visitors;

3. Supporting communities to develop nature-based ecotourism and other ventures that could serve as sustainable destinations for tourists and related blue economy activities;

4. Undertaking a Marine Spatial Plan (MSP) in which 30 per cent of the national marine space would be earmarked for protection to assure that sustainable conservation, marine environment protection and ocean development are guided by an agreed and approved National Maritime Master Plan

2P2R Approach

Prevention and Preparedness: All stakeholders from different sectors should understand and address the primary environmental drivers of emerging infectious disease outbreaks and prevent future crises.

Response and Recovery: This aims at reducing the impact of any COVID-19 economic crisis on the most vulnerable people by safeguarding livelihoods, re-establishing and creating new jobs, and mobilizing well-targeted investments. Ecological and economic vulnerability caused by land degradation are amplified by the increasingly frequent occurrence of drought and sand and dust storms in many parts of the world. In the Sahel, COVID-19 is becoming a threat multiplier. Degraded lands are threatening food security, lowering economic prospects in rural areas and turning young people into economic migrants. Collaboration and synergies with the other Rio Conventions will be reinforced to leverage the role of land and land restoration in the context of the post-2020 biodiversity framework and the nationally determined contributions for climate action.

"The choices we make as we emerge from the COVID-19 pandemic and as the economies open again, will lock in our development pathway for decades to come".

Adjusting communication and networking

One immediate consequence of the pandemic is that conservation and ecology meetings of all sizes have been cancelled for the next few months, and probably even longer. For many small to medium-sized gatherings, online conferencing technology might provide an effective way for people to meet and exchange ideas. For large conferences—like those held by the Society for Conservation Biology and the Ecological Society of America—involving many thousands of people, online meetings cannot replace the networking and interactions that happen at the in-person conferences. In face-to-face meetings, large venues provide unique opportunities to meet a wide range of people with varied expertise, to explore and learn about the latest developments in the field, and to get feedback on one's own projects. Such meetings also are places to reconnect with previous colleagues and collaborators, meet future collaborators and find colleagues who are mutually compatible. A missed conference is a minor concern for established individuals, but for graduate students and early career researchers and practitioners it can be a major loss. The current crisis creates both needs and opportunities for conservation science to communicate more online. Online communications can, for example, draw attention to the links between conservation and human well-being, test models for alternative events, funding, and educational measures, and make meetings more accessible to a larger community.

It is not only academic meetings that are threatened. Two key global intergovernmental meetings planned for 2020 are crucial to addressing the twin environmental crises of our time: biodiversity loss and climate change. The Convention on Biological Diversity (CBD) COP 15 was scheduled to take place in Kunming, China, in October and has now been postponed, with no new date announced as we write this. The purpose of this meeting was to establish a post-2020 global biodiversity framework, and its postponement means that key decisions will be delayed and may have less impact. Similarly, the UN climate change conference COP 26, planned for November in Glasgow, has been postponed, with potentially serious consequences for international efforts to address the challenges of climate change. As the world recovers from the pandemic, we must keep reminding our governments how important ambitious commitments at these two meetings are.

The UNCCD flagship strategic communications tool, the Global Land Outlook 2, will offer a clear channel for delivering evidence-based analysis on the power of sustainable land management and land restoration to Parties and the general public. Future communications on COVID 19 should reflect and respond to the changing conditions and the needs of stakeholders and continuously develop an up-to-date, factual and relevant knowledge on land in the post-COVID19 context thus securing reliable knowledge and data is even more critical to all countries. In this biennium, collaborating closely with the Science-Policy Interface (SPI), the UNCCD secretariat has placed a premium on communicating a science and evidence-based policy on the role of healthy land for people and on the potential of land restoration in preventing and preparing future pandemics (UNCCD, 2020). This is by sharing the knowledge, policies and practices developed under the UNCCD process to help Parties understand the risks of land degradation and capitalize on the continuum of avoided degradation, sustainable management and restoration of land. Harnessing the potential of good land management, can help limit the future zoonotic disease burden.

Sport, Recreation and Green Spaces

Green space is land that is partly or completely covered with grass, trees, shrubs, or other vegetation). Green space includes parks, community gardens, Schoolyards, Playgrounds, Public seating areas and Public plazas. With increasing recreational programmes green spaces are becoming popular venues for such gatherings. This is because of the benefits associated with green spaces as opposed to indoor options. They include:

When training outdoors, you can also enjoy the benefits of sunshine. Fresh outdoor air and natural light invigorate and provide more energy for the mind and body. Sunshine provides the vitamin D that is needed by the skin for synthesis of melanin which acts as sunscreen.

Outdoor workouts are often completely free of charge, because exercise parks, sports tracks, stairs and other exercise locations outdoors are usually open to all and can be accessed free of charge.

Thinking creatively about your surroundings one can devise a training session on a nearby jogging track, hill or stairs or field hence saving time and other resources that would otherwise be used like driving to the gym.

Breaks the routine. One can perform workout that includes variety of movements suitable for terrain and landscape found in outdoor space which addresses more components of fitness.

Most outdoor workout sites such as sports parks and tracks are open to everyone, free of charge. This will enable you to train and spend time exercising together with your friends.

According to the Environmental Protection Agency, indoor air can be more polluted than outdoor air even in large cities and metropolitan areas. Training in the outdoors, one breathes in clean air.

Exercise and Covid-19

Regular exercise is essential for everyone under normal circumstances. However, here are a few reasons why exercise is especially crucial during the COVID-19 pandemic:

Exercise boosts the immune system: Research shows that regular, moderate-intensity exercise has immune-boosting benefits that may help your body fight off infections, including COVID-19.

Exercise may prevent weight gain: Exercise can help you burn extra calories caused by dietary changes and offset the effects of sedentary lifestyle.

Exercise reduces stress and anxiety: Exercise is a proven mood-booster and can help adults reduce stress levels and build emotional resilience.

Exercise improves sleep: There is evidence that suggests regular exercise helps you fall asleep faster and improves sleep quality which has also associated with boosting the immune system.

The Covid-19 virus is primarily spread from person to person through respiratory droplets released into the air when talking, coughing, or sneezing. When you're indoors, you're more likely to inhale these droplets from an infected person, especially if you're in close contact, because you're sharing more air than you do outdoors. Poor building ventilation can cause droplets to hang in the air for a longer period of time, adding to the potential for infection. When you're outside, fresh air is constantly moving, dispersing these droplets. So, you're less likely to breathe in enough of the respiratory droplets containing the virus that causes Covid-19 to become infected.

World Health Organization (WHO) recommendation for exercising during Covid-19 pandemic

Infants under the age of 1 year need to

• be physically active several times a day.

Children under 5 years of age

• should spend at least 180 minutes a day in physical activities, with 3-4 year-olds being moderately or vigorously active for an hour a day.

Children and adolescents aged 5-17years

• all children and adolescents should do at least 60 minutes a day of moderate to vigorous-intensity physical activity, including activities that strengthen muscle and bone, at least 3 days per week.

Adults aged 18 years and over

• should do a total of at least 150 minutes of moderate-intensity physical activity throughout the week, or at least 75 minutes of vigorous-intensity physical activity throughout the week, including muscle-strengthening activities 2 or more days per week.

Older adults with poor mobility

• should do physical activity to enhance balance and prevent falls on 3 or more days per week.

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Disclaimer

A number of sources cited and/or quoted in this paper are attributed to their long experience in research in biodiversity and health matters and not actual research as such the views should be held as such. The paper is also a product of review from different sources of literature.

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Physics Teachers' Belief about Learning from Multimedia and their Self-Efficacy Level to use it

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Abstract

Physics teachers cannot integrate multimedia into their classrooms if they don't believe in its transformative power or if they lack self-efficacy to use it effectively. A convergent parallel mixed method research design was used in this study to examine the physics teachers' beliefs about learning using multimedia and their self-efficacy level to use it. A random sampling method were used to select forty-seven physics teachers from twenty-four schools in Rutsiro and Rubavu districts of western province in Rwanda. A questionnaire was administered to all the 47 physics teachers followed by one to one focus interview. Research findings revealed that even if using multimedia has persisted to be a challenge, participate recognize its benefits in teaching and learning physics. Moreover, findings show that there is no significant difference in the location of schools (rural or urban) in terms of using multimedia in physics classroom and the gender factor is independent of the teachers' beliefs and self-efficacy in using multimedia. However, results indicate that the teachers' self-efficacy in using multimedia differ by age. Participants revealed that increase technology infrastructure and continuous training are major factors to develop teacher's beliefs and raise their self-efficacy to use it.

Keywords: *Multimedia in Education, Teachers' beliefs, Teachers' Self-Efficacy, Physics Education*

Introduction

Currently, more than ever before, our society has introduced new methods and strategies on the essential role that technology plays in society. Multimedia constitute one of the most influential factors of modern technological societies to stay connected to the world. The field of education cannot escape its grip. Many countries are investing in these educational methods that are likely to bring cooperative work, pooling resources, and sharing information (Hennessy, et al., 2010). Moreover, apart from the several benefits of multimedia in enhancing education, its effective implementation still a debate (Almara'beh, et al., 2015; Moos & Marroquin, 2010; and Rusanganwa, 2013). Similarly, researchers (Abbit, 2011; Bingimlas, 2009; Jimoyiannis & Komis, 2017; and Malik, et al., 2019) revealed that many factors contribute to the effective incorporation of multimedia in education including, but not limited to technological infrastructures, national policies aiming at promoting technology in education, teachers' training, teachers' belief about the use of technology in teaching and learning, teachers' self-efficacy in use it and confidence.

Review of Literature

Physics is one of the natural science subjects and significantly contributes to the advancement of engineering, technology, medicine, life, and earth sciences. Physics is essential in education since it promotes science and technology necessary for 21st century learners to be competitive and responsible citizens (REB, 2015). Educators need to change the way physics have been taught to make it relevant and effective since the traditional teaching methods such as thematic descriptions, didactic lectures, classical textbooks, exposition, questioning, and observation...do not develop learner's competencies such as critical thinking, collaboration skills, and creative (Uwizeyimana, et al., 2018). Furthermore, physics concepts, laws, and theories were learned by memorization which cannot easy for students to retrieve; and physics teachers could not explain some mechanisms to students properly because of its complexity (Wagner, et al., 2007).

Within the cognitive domain, basic competence that will develop learners' thinking like problem solving, critical thinking, and creativity as well as communication has been proposed. Consequently, UNESCO (2000) recalls the learning technology as a tool to broaden, soften, and improve relevance and quality of education at all levels. There have been essential to know how the teacher can improve competences to effectively incorporate technology in their teaching. The research revealed that the simple disposal of technology aids only does not automatically lead to effective technology utilization in education (Malik, et al., 2019) but also other factors such as knowledge, beliefs, attitudes, and confidence are crucial factors to effectively integrate technology in education (Antoniette & Marroquin, 2006; Cavas, et al., 2009; Koehler & Mishra, 2009; Weber & Waximan, 2015).

Teachers' beliefs are long-lasting influences of their classroom decisions (Chan & Elliott, 2004), and teachers who hold constructivist beliefs organize learners centered activities that need learners' cooperation and involvement in knowledge construction and teachers to work as facilitators or guides (Davidson & Major, 2014). A study of Kiraz & Ozdemir (2006) found that teachers who use technology more widely also reported bringing greater changes in their teaching practices in a constructivist track. Also, Hallis & Grandgenett (1999) found that teachers who reported a high level in the use of technology also observed themselves as more learner-centered in their teaching practices. Expectedly, teachers with a limited belief about the opportunities in enhancing education practices of technology or who feel uncomfortable utilizing technology are unlikely to integrate it because of the fear related to use something with which they have limited experience (Bingimlas, 2009).

Moreover, the use of multimedia in a classroom is affected by varied factors such as the level to which the structures of

the multimedia are consistent with the teacher's needs, the teacher's experience with multimedia and ICT in general, the teacher's awareness of multimedia and tenacity (Antoniette & Marroquin, 2006; and Nasaruddin & Ismayatim, 2013). Scholars revealed that teachers react to the introduction of new technologies such as multimedia in classroom activities either by accepting them or by rejecting them (Windschitl & Sahl, 2002). Those reactions appear to be grounded on the strong points and weaknesses that teachers identify in the use of multimedia. Scholars revealed that teachers' belief, both benefits, and limits refer to three main issues: i) motivation and/or involving the power of multimedia (Moos & Marroquin, 2010; and Mouza & Bell, 2001), ii) facilitating and/or optimizing effect that multimedia can produce in learning processes (Antoniette & Marroquin, 2006 and Norlis et al., 2018), and iii) the development of high level reasoning activity (Antoniette & Marroquin, 2006 and Moos & Marroquin, 2010)

Similarly, according to Bandura (1982) an influential social cognitive psychologist, self-efficacy is defined as the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations; and Chao (2003) shows that self-efficacy depends to behavior, individual's personality and environment. On the side of learning technology, several domains such as competence and capabilities of self-efficacy beliefs might play a role in a teachers' views, decisions, and activities regarding technology in the classroom (Abbit, 2011). Scholars revealed a positive relationship between teachers' general ICT self-efficacy for instructional purposes and the use of ICT in teaching and learning (Hatlevik & Hatlevik, 2018). Fanni, et al. (2013) revealed that self-efficacy and use of technology in teaching verifies Bandura's assumptions and emphasizes the notion that increasing level of computer self-efficacy can lead to higher levels of confidence in being an efficient teacher with technology. Recent research revealed that teachers' self-efficacy has no significant gender differences (Scherer & Sddiq, 2015) and that urban teachers did not make more external attributions than the rural and suburban teachers (Knoblauch & Chase, 2014). However, it was found that teachers' age was a significant factor influencing the extent to which technology is used in teaching (Yushua & Nannim, 2020).

Many scholars attribute slowness utilization of multimedia to teachers' lack and/or pool self-efficacy in integrating such teaching methods into their classroom (Aravind, 2016; and Bingimlas, 2009). In east African countries, numerous reasons, including work related and personal issues were revealed as playing important role in developing teachers' self-efficacy and motivate teachers to adopt certain behaviors (Hardman, et al., 2011). Similarly, the reform of the curriculum of Rwandan secondary schools in 2015 acknowledged that teachers play a vital part in enhancing student's skills, it becomes crucial for teachers and schools to be equipped with the 21st century technological skills as well (MINEDUC, 2017; and REB, 2015). Nevertheless, if teachers lack some aspects connected to self-efficacy such as plan and preparation for multimedia instructions, constructivism thinking, and motivation to bring teaching methods that target such skills, they will not be likely to incorporate multimedia in their classroom (Kiraz & Ozdemir, 2006).

Research Problem and Focus

Although the benefits of multimedia in education have been perceived by many research worldwide (Almara'beh, et al., 2015; Malik & Agarwal, 2012; and Ugwu & Nonyelum, 2019) on the other hand, researchers (Marx, 2010; and Winner, 1986) still doubt on their effective influence to enhance education for the better or had no qualm about multimedia better educational golden opportunities in developing education practice. Accessibility to multimedia aids, appropriate infrastructure, national policy, teachers' training, and self-efficacy are fundamental building blocks to effective and efficiency multimedia integration in education. However, the disposals of the technology tools only do not lead automatically into positive and effective incorporation of multimedia in education (Malik, et al., 2019). Teachers' belief, concern, and willing to use ICT in education (Jimoyiannis & Komis, 2017) is another pillar that was left behind by many authors; and it is commonly known that teachers' educational beliefs are strong indicators of their planning, instructional decisions, and class practices (Bandura, 1986). Consequently, there is a need to study Rwandan physics teachers' belief in learning from multimedia and their self-efficacy level to use it. The overall objective of this study is to contribute to the effective integration of ICT in general and particularly multimedia in Rwandan secondary schools for improvement of teaching and learning physics.

Research Methodology

Research design

A convergent parallel mixed method research design was employed in this research. Following the road map of the pragmatic world view (Leavy, 2017), this research combined both qualitative and quantitative approaches to provide a comprehensive analysis of the research problem.

Research Participants

Research participants were in-service physics teachers in Rutsiro (Rural settled district) and Rubavu (Urban settled district) districts at the beginning of the school year 2020. Twenty-four schools (12 in each district above) that have SMART classroom also known as computer laboratory or ICT room and physics as one of the core subjects taught in

the school were randomly selected and then all physics teachers in a school were requested to participate in this study. Forty-seven physics teachers were selected and participated in this study.

Research Instruments and Validation Procedures

The questionnaire had closed ended and open-ended questions. The questionnaire covered five sections namely: demographic information, use of multimedia in the physics classroom, benefits of multimedia in teaching and learning physics, teachers' self-efficacy in using multimedia in teaching and learning, and seeming barriers to effective multimedia implementation in teaching and learning physics. However, only three sections: demographic information, benefits of multimedia in teaching and learning physics, and teachers' self-efficacy in using multimedia in teaching and learning have been reported because they are supposed suitable to address the stated research questions. To formulate research questionnaire items, we selected and adapted from a large review of scientific literature items in line with previous research in the field with multimedia in education to guarantee that items related to the ones that have been validated and checked for reliability before. Since the purpose, scope, and scores are not the same as the original ones, reliability analysis and validation were carried out before administering the questionnaire.

An exploratory factor analysis using principal component extraction with SPSS Version 21 shown that all the items' factor was greater than .40 and are all retained and presented in this study. The items were analyzed for internal consistency and give a Crobach alpha of .85; this was considered acceptable since it was greater than the recommended of .7 (Taber, 2017). There is no multicollinearity among the items since there are no pairs inter-item correlations of more than .80, so all items were independent.

Data Analysis

Since the data in this study are made of text from the open-ended questions and numbers from closed ended questions, their analysis involved both qualitative and quantitative aspects. To analyze quantitative data, SPSS V.21 was used to carry out descriptive and inferential statistics. To analyze qualitative data, a thematic analysis that attempts to identify patterns of themes in data were used (Braun & Clarke, 2006). Respondents' views were arranged in short sentences assigned them codes to describe the content and then search the corresponding patterns or themes in our referencing codes.

Ethical Considerations

Ethical issues were maintained at all stages of data collection and analysis. Before starting this research, ethical approval was sought and approved by the research and innovations directorate of the University of Rwanda, college of education. All participant willingly participates in this study. The permission to collect data from the selected schools was granted by the mayor of Rutsiro district and executive secretary of Rubavu district in Rutsiro and Rubavu district respectively, director of district education officer in both districts and head teacher of selected schools.

Research Results

Personal and Professional Information

In this study, 47 teachers from 24 public secondary schools located in two districts Rubavu (Urban based) and Rutsiro (Rural based) participated willingly. 26 (55.3%) teachers are from Rubavu and 21 (44.7%) are from Rutsiro. 35 (74.4%) are male and 12 (25.6%) are female. The average age is 34.6 years old with an average of services experience in the teaching of 8.1 years. Among the respondents, 51.0% hold Bachelor of Science (Major in physics with or without another subject) in education, 25.6 % hold Bachelor of Science with a post graduate diploma in education (PGDE) or post graduate certificate in education (PGCE), 21.2% with a diploma in science with education and 2.2% with master's in education. 44.7% received at least once training about the integration of technology in education and 71.7% have a personal computer. Note that the choice of participants was done randomly; this can clarify and explain the difference in respondent's personal and professional information and the differences between the rates of male and female.

Use of Multimedia in Physics Classroom

Table 1 shows the frequency of the level to which teachers agreed or disagreed with the use of multimedia (and ICT in general) per week and with the most combination of media they use in the physics classroom. The following criteria were used: 1= strongly disagree, 2= disagree, 3= neutral or not sure, 4= agree, and 5= strongly agree.

Referring to table 1, the most combination of multimedia in teaching and learning physics are: video + sound (93.6%), on screen text + image +sound (85.1%), animation + sound (74.5%), and animation + on screen text (55.3%). Animation + narration is rarely used with 14.9%.

Table 1: Use of Multimedia in Physics Classroom

Number of Periods per Week	Frequency (%)				
	1	2	3	4	5
1-2 periods per week	0	0	19.2	29.8	51.0
3-4 periods per week	27.6	25.6	21.2	12.8	12.8
5 and above periods per week	78.8	21.2	0	0	0
Combination of Multimedia					
Video + Sound	0	0	2.1	40.4	53.2
On screen text + Image + sound	0	0	14.9	40.4	44.7
Animation + Narration	38.3	29.8	17.0	12.8	2.1
Animation + on screen text	2.1	19.1	21.3	25.5	29.8
Animation + sound	0	0	25.5	27.7	46.8

Results presented in Table 1 also indicate that a significant number (more than 50%) of respondents persuaded to agree or strongly agree that the extent to which multimedia-based instruction and ICT in general use in the classroom is 1 to 2 periods per week (80.8%), few can reach 4 periods per week (25.6%), and no one used 5 periods and above per week.

Table 2: Teachers' belief on Multimedia in Teaching and learning Physics

No	Item	Frequency	%
16	Multimedia provide access to the digital library where the information can be retrieved and stored beyond text book	36	76.5
8	Multimedia are attractive and arouse students' curiosity	36	76.5
4	It is difficult to control students behavior in multimedia class	34	72.3
18	Multimedia reduces time spent on mechanical tasks such as rewriting	34	72.3
9	Multimedia build and maintain personal and professional relationship	33	70.2
5	Multimedia promote self-efficacy and confidence	33	70.2
10	Multimedia prepare students for 21st century	30	63.8
3	Multimedia helps to be familiarized to smart technology	27	57.4
17	Multimedia increase the scope of searching	27	57.4
19	Multimedia are too demanding in terms of preparation and implementation	26	55.3
11	Multimedia facilitate communication and promote creativity	26	55.3
6	Multimedia improve students learning and better teaching methods	24	51
12	Multimedia amplify learners' engagement	24	51
2	Multimedia strengthen learners' motivation	24	51
15	Multimedia increase learners' conceptual understanding and retention	23	48.9
13	Multimedia increase learners' critical thinking	23	48.9
7	Multimedia helps to achieve the latest knowledge	11	23.4
1	Multimedia helps to find and organize information	10	21.2
14	Multimedia helps to transmit, store, share and/or exchange information	9	19.1

Table 2 illustrates the answers of respondents that were simplified in short sentences in decreasing order respect to the values of repetition recorded.

The main issues, in this axes, that the items in questionnaire emphasized on are optimizing effects that multimedia are likely to produce in the learning process and factors that stimulate (or sedative) the multimedia in teaching and learning physics

Results in table 2 above show that majority of teachers have a strong positive belief that multimedia is a powerful tool to shape physics education. The findings also revealed some factors that interfere negatively (items 4 and 19) thus making teachers careful (and/or doubtful) about multimedia use in the physics classroom. The checkup of the list of the recoded answers show that multimedia is essential to schools (3, 7, 14, 16); teaching and learning (2, 6, 11, 12, 13, 15); teachers (1, 9, 17, 18); and students (5, 8, 10).

Self-Efficacy in Using Multimedia in Physics Classroom

The deep analysis of table 3 shows that, in general, there is no significant difference (only two items out of 12 i.e.16.7%) on the location of the school, urban or rural, as far as the teachers' self-efficacy is concerned.

Table 3: Comparing Rutsiro-Rubavu Teachers' Self-Efficacy in Using Multimedia in Physics Classroom (Rural vs. Urban)

District	N	M	SD	t	P-value
Rutsiro	21	3.05	0.826	0.776	0.442
Karongi		2.85	0.925		
	26				

Results displayed in table 3 indicate that there is no statistically significant difference in teachers' self-efficacy in using multimedia in teaching physics between urban and rural teachers. The reasons are that the calculated p-value of 0.442 is higher than the 0.05 alpha level of significance while the t-calculated value of 0.776 is less than the t-critical of 1.96, and their calculated used mean is 3.05 and 2.85 for rural teachers and urban teachers respectively indicating that geographical location has no significant influence on teachers' self-efficacy in using multimedia in teaching and learning physics.

Table 4: Comparing Female-Male Teachers' Self-Efficacy in Using Multimedia in Physics Classroom.

Sex	N	M	SD	t	P-value
Female	13	3.25	0.754	1.462	0.151
Male	34	2.82	0.904		

The calculated p-value of 0.151 which is higher than the 0.05 alpha level of significance and the t-calculated value of 1.462 which is less than the t-critical of 1.96 revealed that results presented in table 4 indicate that there is no statistically significant difference in teachers' self-efficacy between men and women in teaching physics using multimedia.

Table 5: Comparing Teachers' self-Efficacy in Using Multimedia in Physics Classroom in Terms of Age

Table 5 illustrates the statistical output regarding teachers' self-efficacy respect to their age.

Source of variance	Sum of squares	df	Mean of squares	F	sig
Between groups	12.464	5	2.493	4.463	0.003
Within group	22.34	40	0.559		
Total		45			
	34.804				

Respondents were requested to rate their level of self-efficacy from 1 to 5. Teachers' age was grouped with an interval of 5 years and we come up with five groups of age i.e. 26-30; 31-35; 36-40; 46-50; and 56-60. The analysis within group did not show a statistically significant mean difference. However, the results show that teachers' self-efficacy in the use of multimedia in each age group is significantly different ($p<0.05$, ANOVA- one way). This implies that the teachers' self-efficacy in using multimedia in physics classroom differ by age.

Suggested Solutions for Improving Multimedia in Physics Classroom

Requested to suggest ways through which multimedia in the physics classroom (even other subjects) could be effectively implemented and enhanced, respondent's suggestions were gathered into main groups: external and internal. For external, teachers' suggested that the government should provide continuous and quality training about the use of multimedia for education purposes. Teachers revealed that there is a need to provide ICT tools such as computer and internet connectivity to teachers, to improve the school infrastructure and augment the schools' ICT tools such as computers, projectors, interactive white boars, and speakers. Teachers also put forward the harmonization of teachers' load and class size.

Ones say:

Technology thrives every day; we (teachers) need to be up to date too. The government should provide computers to teachers as it was done for students. The class size is too large, it requires a lot of time and energy to monitor students. The teachers' load is too big to get enough time to prepare effectively.

Others say:

Teachers need facilitations such as internet connectivity not only at school but also at home and everywhere else. The number of ICT aids are not enough vis à vis the number of students and teachers in need.

The internal is that teachers need to change their minds about teacher's attitudes towards the use of multimedia in the physics classroom, motivation, and resistance to change.

One said:

Some teachers remain mentally married to the idea that multimedia (and ICT) in education is time consuming! This is a failure of mindset that led to resistance. Multimedia should be used but not dominated classroom activities.

Teachers believe that government policy about the incorporation of technology in education is systematical achievable and is on good track so far. They say that the bad ideas about technology in education are not the technology itself, but the way is being implemented. Teachers expect enough training and facilities to effectively incorporate multimedia in the physics classroom.

Discussion

Ensuring a better learning environment and good practices are teachers' responsibilities; failure to meet standards could result in loss of credibility. To address those issues, using multimedia makes sense since today' learners are digital natives (Margaryan, et al., 2011). Teachers' beliefs are foundations to their sense, confidence, and level of self-efficacy to use multimedia in their classrooms. The present research revealed teachers' beliefs and concerns related to the use of multimedia in teaching and learning physics and their self-efficacy level to use it for educational purposes in selected secondary schools physics classroom.

The use of multimedia in a physics classroom, the results of this study showed that most teachers use one to two periods per week (80.8%). Note that the maximum periods per week, under normal circumstances, are 7 periods and one period equals forty minutes (REB, 2015). Following the recommendations of previous researchers, this is a very good stepping strategy of integrating multimedia in physics education because studies show that if technology monopolizes an activity, learners can begin to develop the sense that life would scarcely be thinkable without technology (Winner, 1986). Domination of video- sound in the integration of multimedia in education in this study looks like, to some extent, those of Aravind, (2016) and Gambari, et al., (2016) which indicated that video based mode of learning effectively enhance self-learning and engages learners' attention as it addresses different learning styles of visual, and auditory learners.

On the factors that stimulate teachers to use multimedia and the optimizing effect that multimedia are likely to bring in the physics classroom, the results of this study show that multimedia is essential to school due to its multiple benefits. This study also revealed the welfares of multimedia to learners by promoting their self-efficacy and confidence, attracting and arousing their curiosity, and preparing them for the 21st century. All those findings of this study highlighted above are similar, to some extent, to the findings of Aravind (2016), CEMCA (2003), and Rusanganwa (2013) on the benefits of multimedia in education.

However, this study also exposed differents hindrances vis à vis the use of multimedia in the physics classroom. The results of this study show difficulty in class management as the revealed that it is difficult to control student's behavior in multimedia class and limitation in time as the revealed that multimedia is time consuming and is too demanding in terms of preparation and implementation to already overloaded timetable. Although class management is a critical issue especially when dealing with large class (Nye, et al., 2000) study of Singh & Singh, (2014) shows that multimedia-based instruction use creates a good environment for learning, eases classroom management, helps saving time and offers more opportunities for more events. There is a need to understand that it is the use of technologies in education that make the difference and not the technologies themselves.

Thirdly, on the teachers' self-efficacy, the results of this study show that, in general, there is no significant difference in the location of the school, urban or rural, as far as the teachers' self-efficacy is concerned. These results contradict the results of Wang (2013) who found that urban teachers reached the level of familiarity and confidence while rural teachers only stayed at the level of understanding and application of the process. On the other axis of gender, the results show that there is no significant difference in self-efficacy in using multimedia in the physics classroom between men and women. This result is the same as the results of Gebhardt, et al., (2019) who showed that analyses of female and male teachers' experiences, dispositions, and uses of ICT indicate that any differences are small and inconsistent across countries. After all, in the Rwandan context, due to the rapid pace of increasing ICT accessibility countrywide and different programme aiming at effectively ICT integration, teachers become dated, and female and male teachers in secondary schools do not appear to differ.

However, the results of this study shown that the teachers' self-efficacy in using multimedia in physics classroom differ by age. Results show that young teachers have higher self-efficacy levels and more positive views towards multimedia in physics education that their predecessors. Our results contradict, to some extent, those of (Yushua & Nannim, 2020) who found that unless age factor still appears to be critical in encouraging positive beliefs about ICT in education, old lecturers used ICT more than young ones in teaching. Therefore, systematic workshops and training aimed at increasing teachers' level of exploitation of multimedia should be organized.

Fourth, participants made suggestions on how to effectively implement and enhance multimedia in the physics classroom. Some respondents pointed out that there is a need to provide continuous and subject oriented quality training about the use of multimedia in a pedagogical way. This suggestion is similar with what has been recommended by Myers & Halpin (2002) that training strategies designed and implemented in the existing curriculum helped teaches to enhance positive attitudes towards utilizing multimedia and computer in their classroom and affected teachers' share of training in their classroom.

On the other hand, teachers' resistance to change was reported as a major hindrance to effectively incorporate multimedia in a physics classroom. However, participants revealed that this resistance is due to pressure to prepare learners for tests and examinations. Consequently, teachers are required to teach students to memorize theories that are likely to feature in their final examination. Drawing to Zin, et al., (2013) that educational technology posed challenges and responsibilities to teachers and requires more than the involvement of the students, most of the respondents point out that multimedia based instructions require much time and energy. Thus, some teachers choose traditional methods that would facilitate them to complete the syllabus and make their learners pass the tests. Nevertheless, this is in contradiction to the guidance provided by the newly introduced Rwandan curriculum for secondary school physics (REB, 2015) which emphasis promoting skills and competence that are relevant to global socio-economic transformation and led to the development of new technologies. To this, there is a need to orient teachers on how to address those worries and to train them on how to effectively and efficiently incorporate multimedia in the physics classroom.

Conclusion

The purpose of this research was to explore the teachers' beliefs and concerns about learning from multimedia and their self-efficacy to use it for education purposes. Respondents witnessed the benefits of multimedia in the physics classroom, its influence to shape education, and the opportunities in vital enhancement to education practice. Respondents also perceived their self-efficacy to integrate multimedia in teaching physics in a highly didactic way. However, participants revealed that teachers with advanced age particularly need more substantial reasons about the worth and the helpfulness of multimedia in the physics classroom and training targeting teacher's multimedia (and ICT in general) incorporation in teaching and learning should be flexible, continuous, and subject focused rather than identical or same for all.

The analysis of the results allows us to group, as far as the teachers' belief about learning from multimedia is concerned, into two main groups. Optimists and pessimists. Optimists here, according to participants' views are those teachers who believe that multimedia will positively shape the physics teaching and learning process in general. Here results placed teachers with a personal computer, teachers with minimum training about effective integration of ICT in education, and young teachers; there is no location (urban or rural) or gender significant influence at this point. Pessimists, according to study results are those teachers who do not believe or still doubt in transforming power ability that multimedia is likely

to bring in teaching and learning physics; in this group we locate, mostly, teachers with advanced age, teachers without personal computer and teachers without training in effective integration of ICT in education; gender and school location do not significantly contribute to this axis.

On the other hand, teachers revealed that teachers' self-efficacy in using multimedia for education purposes is totally independent of gender. The same results also have shown that geographical location contributes a little to teachers' self-efficacy. However, teachers' age contributes a lot to teacher's self-efficacy from the higher level of multimedia self-efficacy special young teachers, trained teachers and teachers with minimum technological tools required in education like a computer to a lower level of multimedia self-efficacy like old teachers, teachers without training aiming at the incorporation of ICT in education and teachers without minimum technological tools required in education like a computer. After all, the effective integration of multimedia necessity increases in technological infrastructure, continuous and subject based training aiming at the effective and efficient incorporation of multimedia in teaching and learning.

Limitations and Recommendations

To amplify the likelihood teachers' belief in teaching and learning from multimedia and to raise the teacher's self-efficacy are the major keys to effectively incorporate multimedia and technology in general in the physics classroom. This study will add value to the effective implementation of multimedia and visual learning in Rwandan secondary schools. However, respondent's status as public schools teachers might have influenced them to amplify or reduces their beliefs and/or self-efficacy about learning from multimedia. Hence careful analysis is needed when interpreting the results of this study. Consequently, it is recommended that further research could investigate the students' belief about learning from multimedia and examined the students' self-efficacy on learning from multimedia. To be aware of factors that can inspire teachers' self-efficacy in using technology in education is also a vital subject to investigate.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Preparedness towards Online Learning in the wake of Covid-19 Pandemic

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Abstract

The outbreak of the deadly coronavirus disease (Covid-19) caused the closure of education institutions worldwide basically because institutions of learning lacked the capacity to implement the Covid-19 safety measures like strict adherence to the social distancing rule. Most institutions already had and still do have congestions in that the scarce basic facilities like hostels, laboratories, libraries, dining halls and toilets are usually shared by many. The Ministry of Education in Kenya guidelines to learning institutions urged for the adoption of online teaching and learning to ensure continuity of learning. Challenges revolving around institutional and learner preparedness towards virtual learning greatly impacted on the whole process. This paper discusses preparedness towards virtual teaching and learning in Kenya.

Keywords: *e-learning, Technology enabled learning*

Introduction

Electronic-learning in its extensive experience can be described as trainings introduced through a digital media such as the internet, intranet, extranet, satellite-TV for pc broadcast and furthermore, as reported by (Challis; Lidgey, & Robertson, 2003); e-learning is utilizing ICT in coaching and mastering. (Rossi, 2009); stated that e-learning as an idea covers a scope of utilizations, learning techniques and procedures. E-learning improves the viability of learning and capabilities by means of straightforward entry to an enormous measure of information. It can give chances to relations between scholars by utilization of conversation forums. Via this, e-learning dispenses with boundaries that have the capability of impeding cooperation including the apprehension of conversing with a different scholar. Electronic training inspires scholars to converse with different scholars, and also trade and regard diverse purpose of perspective. Additionally, e-learning facilitate correspondence, and enhances the connection that manages learning.

Rhema's & Miliszewska's (2014) meta-analysis study revealed that the factors that affect students' attitudes towards online learning can be divided into two main groups: demographic (age and gender) and computer skills (ICT training background, experience in working with ICT, possession of own computer, access to ICT, frequency of using computer).

During the Covid-19 period, online students' learning seems faced with the issue of inadequate equipment. Lecturers do not have the equipment and appropriate materials in place. Server crashes, unstable networks, endless registration on various apps are some of the problems. Seldom do they have the skills and expertise to record lessons. According to (Smedley, 2010); "appropriation of electronic training gives impressive establishments and in addition their scholars the adaptability of time and location of conveyance as indicated by learning data."

Some students have a feeling that e-learning platforms are not personalized. The contentions against web learning are revolved to a great extent around the attractiveness towards the loss of customary study hall, eye to eye association and the probable sentiment of disconnection this can conceive. Wang & Newlin (2001) recommends that the lion's share of online trainings still embrace an asynchronous method of learning; asynchronous training constrains, the sum and profundity of association amongst both scholars and instructors.

Student attitudes are influenced by the quality and perceived ease of use of e-learning courses, functionality of e-learning platforms, and the level of student computer skills (Aixia &Wang; 2011). Their computer experience including perceived self-efficacy, enjoyment, and usefulness of using e-learning also plays a role (Liaw & Huang, 2011). In turn, positive student attitudes and behaviors towards e-learning are critical to their e-learning readiness and acceptance (Lim, Hong, & Tan, 2008; Selim, 2007).

Nassoura (2012) pointed out that many students had positive attitudes towards e-learning because it had a positive impact on their motivation as well as self-esteem. Selim (2007) concured and stated that users who were very familiar with web technologies and the skills needed to use computer and mobile devices for instruction developed positive attitudes. On the other hand, students who were not skilled in ICT became anxious about the use of computers, had lower expectations from educational technology, and they did not believe in the benefits of e-learning (Vrana, Garyfallos, Zafiropoulos, & Paschaloudis, n.d.).

Bhuasiri, Xaymoungkhoun, Zo, Rho and Ciganek (2012) found that in developing countries the most significant factors were related to increasing technology awareness and improving attitude toward e-learning, enhancing basic technology knowledge and skills, improving learning content, requiring computer training, motivating users to utilize e-learning systems, and requiring a high level of support from the university.

In the prevailing abnormal circumstances of Covid-19 restrictions, most parents who are not teachers may not be in a position to provide conducive learning environment for their children to concentrate leave alone provide the required

electronic materials. Some students may be obstructed during online lessons for instance by falling asleep, playing an online game, watching TV, chatting with friends on social media and so on. Many youths would therefore rather go online in search of news or just to pass time on social media instead of constructive online academic engagement. According to Hussain (2007), students selected for a study on e-learning in Pakistan indicated that they faced many difficulties in accessing ICT facilities and this limited their ability to use technologies.
Chen and Huang (2012) stated that understanding student attitudes can help expand e-learning system functions and meet student needs, which should further increase the impact of learning and enhance satisfaction with the learning process. Aixia and Wang (2011) found that the vast majority of students who were satisfied with an e-learning environment held positive believes and attitudes towards it; perceived satisfaction was identified as one of four factors that helped explain 83.8% of the variance of student attitude.

Rhema's & Miliszewska's [5] meta-analysis study revealed that the factors that affect students' attitudes towards online learning can be divided into two main groups: demographic (age and gender) and computer skills (ICT training background, experience in working with ICT, possession of own computer, access to ICT, frequency of using computer).
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Preparedness of Institutions for Virtual Learning in Kenya
The suspension of face to face learning in learning institutions in Kenya put university managers off guard. Most institutions of learning were forced to put in place aspects of Technology-Enabled Learning (TEL) systems, policies and infrastructure, and were in the process of developing robust systems when it became apparent that closure of learning institutions for face to face learning was a reality. Institutions ought to improve their ICT infrastructure in order to boost TEL and to accommodate both blended and eLearning modes of study. A number of students can't access the content on the Learning Management System (LMS) due to lack of relevant infrastructure (laptops or smart phones or even Internet bundles). Most of the fresh undergraduate students are practicing how to use smart phones and computers, this gives them a challenge in accessing the LMS platform and attend to learning activities given by the lecturer in their respective courses.

There is great need to encourage students to own their ICT devices and to effectively use them, this is likely to enhance academic achievement, deep understanding, exploring many topics, ease of collaboration, improved IT management and improved career prospects. It is worth noting that, adoption of technology blended learning comes in with technological implications such as increased class absenteeism, interfering with concentration and mobile distraction in class which should be borne in mind during implementation of TEL. Furthermore, students are alive to the fact that for specialized courses, practical learning has to be provided by the institutions themselves. This is an indicator that online teaching is not a complete substitute for on-campus learning. After the reopening of schools and universities, students are assured of supplementary and enhanced courses to be arranged, they may therefore not take online learning seriously.

Conclusion
Online lessons ought also to have varied activities, the activities should relate directly to both the class content and students' interests from their inventory. Students should see these activities as challenging and fun, and not just another meaningless exercise for the sake of killing time. If varied activities aren't presented, students are likely to switch off with ease. As phased re-opening of institutions is being implemented, TEL should be embraced by all institutions. Inclusion of the use of social media in teaching and learning along with having robust policies to integrate LMS in courses is the way to go. In order to strengthen the use of ICTs, there is need of training of teachers as well as students
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Distance Learning Students' Mobile Phone Self-Efficacy and Utilization for Learning: A Case of St. Paul's University Portable Object-Oriented Dynamic Learning Environment (POODLE) Application, Kenya

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Abstract

Mobile phones are used in virtually every area of life in the contemporary society. In Africa, mobile phones have radically changed the way people do business and socialize, Kenya has not been left behind in this development. However, mobile phone technology has not been effectively utilized in education at the same level of efficiency and effectiveness. Studies have shown that technology self-efficacy is the most critical factor that determines utilization of any technology particularly for distance education students. Distance education students need effective support through mediated forms of interaction in form of flexible media and hence the development of the POODLE mobile application learner management system at St. Paul's university, Kenya. This study aimed at studying mobile phone self-efficacy and utilization for learning with special reference to the use of POODLE application at St. Paul's University. A descriptive cross-sectional survey research design was used. The study targeted 320 respondents. A questionnaire was used to collect data from a sample of 176 students. Data obtained was analyzed by use of frequencies, percentages and Pearson Chi-Square(x^2) at a set significance level of ($p < .05$) and presented in form of tables. The findings of the study revealed that most students used the POODLE application though slightly more male students used it than their female counterparts. The study revealed no significant relationship between students' year of study and the use of POODLE application. Attitudes of students using the application varied but most regarded the POODLE application as useful in their studies. Most students had skills in the use of the application but there was a significant relationship between the distance learning students' year of study and the students' self-evaluation on whether they have the skills in the use of POODLE application. The conclusion of the study is that mobile phone applications utilization and self-efficacy among St. Paul's University distance learning students is relatively high. However, there is need for more sensitization, training and regular updates of the application to increase distance learning students' self-efficacy and utilization of the POODLE application.

***Keywords**: Mobile Phone, POODLE Application, Self-Efficacy and Distance Learning.*

Introduction

Mobile phones have dramatically changed the social and economic life of human beings over the last few years. This is more pronounced in a number of African Countries especially in Kenya. Lep, Barkley and Karpinski (2015) note that mobile phones are an integral part of human life today. Iraki (2015) contend that this has largely been brought about by affordability of mobile phones and access to internet services. In its report, the Communication Authority of Kenya(2016) indicate that by end of 2016 an estimated 62.9 percent of the population worldwide already owned a mobile phone representing about 4.77 billion people and was expected to grow to 67% or about 5 billion people by 2019. Statistics from the Communication Authority of Kenya indicate that by June 2017, there were 39.7 million (90%) mobile subscribers in Kenya. By December 2018, there were 49.5 million (106%) mobile subscribers in Kenya (CAK, 2019). As a result of the rapid and extensive mobile penetration and use of smart phones, internet usage has equally increased. The Global Digital Report (2017) postulates that by January 2017 there were 3.77 billion (50%) of the world's population internet users in the world. This growth has been attributed to the use of smartphones with remarkable capacity and versatility. Smartphones have opened new opportunities, creative and varied applications in different areas of human life.

Mobile phone technology has had a great impact in various fields such as communication, banking, financial transactions and agriculture among other areas. In Kenya, products such as M-Pesa and M-Swari have revolutionized money and financial transactions as well as business payments. However, as noted by Iraki (2015) mobile phone usage in the teaching and learning process is very low. Cheon, Lee, Crooks and Song (2012) opine that mobile learning has been widely used in informal learning but has had low usage in formal learning. This is despite the fact that they can provide, mobile flexible, practical, and personalized opportunities of use in and outside the classroom (Kukulska-Hulme & Traxler, 2005). Vasquez-Cano (2014) and Yang (2012) agree with this assertion when they argue that use of mobile phones for learning would play a fundamental role in University education by facilitating and extending access, knowledge construction, information collection and exchange, independent and lifelong learning as well as collaborative learning among other benefits. Smartphones in particular enable quick content delivery, enhanced support time, a higher level of student engagement in learning in a multitude of diverse geographical locations. (Clough, Jones, McAndrew, & Scanlon, 2007; Cowie et al., 2009; Falaki et al., 2010).

In distance education, the teacher and the student are largely removed from each other in both space and time. This brings in the absence of interaction in the teaching and learning process found in conventional classrooms. Holmberg (1983) and Moore (1993) opine that in distance education, there is both a geographic separation between the teacher and the learners and a pedagogical one. There is thus a psychological and communications space to be bridged and a space of likely misunderstandings between instructors and students who are physically separated. According to Anderson (2010), interaction, is fundamental to educational experience. Studies have indicated that students' learning is largely determined by social interaction through problem-solving under the guidance of a teacher or in collaboration with peers (Brindley & Paul, 2004; Garrison & Shale 1987; Lave & Wenger, 1991). Thus, distance education requires providers to use technology to mediate interaction between students and students. The fundamental concern by providers in distance education, is the use of the best technology that can support such interaction.

As noted by Bull & McCormick (2012) and Tao & Yeh, (2013) mobile phone technology provides students with immediate, portable access to education-enhancing capabilities. It is also an accessible, relatively cheaper form of technology that offers learning that is intimate, spontaneous, pervasive and versatile and meets the need for interaction. Zhou (2014) and Kukulsa-Hulme and Traxler, (2005) argue that the main advantages of mobile technology is the ability support situated learning and mobility. In distance education, mobile phones can be very useful in mediating interaction between students and lecturers and for students support in their learning. In universities as noted by Lep, Barkley and Karpinski (2015) and Cheon, Lee, Crooks and Song (2012), most students and lecturers have mobile phones. However, they are mainly used for communication and leisure activities such as social networking, internet surfing, watching videos and playing games.

Self-efficacy in relation to the use of any technology is very important in the uptake and utilization of technology. Technology self-efficacy can be defined as an individual's self-judgment on one's ability to use the technology. Adedoja and Oluwadara (2016) point out though there are many factors that influence the uptake and use of technology, findings from a number of studies reveal that technology self-efficacy is a major factor in the adoption and use of a technology. Isman and Celikli, (2009) note that students' technology self-efficacy and attitudes are the core factors which determine the success of the students' participation and use of the technology. Aremu and Fasan (2011) and Chia-Pin & Chin-Chung (2009), though interested in the training of teachers intimate that self-efficacy in the use of any technology is important in the acquisition of required competence and attitude for effective utilization of the technology. This is a clear indication that for effective use of mobile phones in learning by distance learning students, self-efficacy should be evaluated and considered. Yang (2012) argue that studies done by Brock & Sulsky, 1994; Barbeite & Weiss, 2004; Kao & Tsai, 2009) have shown that technology self-efficacy influenced by the psychological factors, including computer anxiety and the perceptions toward computers as helpful and self-directed tools. It is therefore imperative to determine self-efficacy and utilization of any technology developed and in use in order to improve on its usage and uptake and hence the need for this study

St. Paul's University developed a mobile phone application learner management system (LMS) known as POODLE (Portable Object-Oriented Dynamic Learning Environment) in 2019 for use by distance learning students and lecturers. It mirrors the MOODLE (Modular Object-Oriented Dynamic Learning Environment) learner management system (LMS) platform. It is designed for Android operating system mobile phones. The POODLE application can be downloaded through the Google Play Store. It allows users to utilize mobile internet networks and access learning materials offline thereby making access to the e-learning platform easier, flexible and versatile for both students and lecturers by improving access, flexibility, quality and interaction between students and lecturers. The POODLE was developed to mitigate e-learning LMS user challenges such as access to cabled internet network, resistance and complaints over accessibility among others. Considering that the POODLE application had been in use for two years since its implementation at the University, there was need to study on its utilization and efficacy among distance learning students and hence the purpose of this study. This will not only help in improving its usage but also inform future designs, development and use of mobile phone-based technology in university distance education at St. Paul's University as well as other universities and institutions of higher learning.

The purpose of this study was to find out distance learning students' mobile phone self-efficacy and utilization for learning. The study is based on the Technology Adoption Model (TAM) by Davis (1989). The study objectives were to; assess the level of POODLE mobile phone application utilization by distance learning students at St. Paul's University and find out distance learning students' self-efficacy in utilization of the POODLE mobile phone application in learning.

Materials and Methods

A descriptive cross-sectional survey research design was used in this study. Fraenkel and Wallen, (2009); Borg, Gall and Gall, (2003) contend that a descriptive cross-sectional survey design is good when the study aims at describing a phenomenon or characteristic associated with a subject, estimate proportions of a predetermined population that have these characteristics and discover associations among different variables at a specific point in time. In this study, the characteristics of interest already existed in the subjects and thus allowed the researchers to do an in-depth analysis and associations of the variables of study. The study was carried out between March to April 2018.

The target population of this study was all the 320 distance learning students using the St. Paul's University E-learning learner Management system. Stratified random sampling based on gender through the use of a table of random numbers was used to select 176 students as indicated in Table 1.1.

Table 1.1 Sample of Respondents Based on the Programmes of Study

Respondents Programme of Study	Frequency	Percent	Valid Percent	Cumulative Percent
Bachelor of Business Administration	86	48.9	48.9	48.9
Bachelor of Arts In Leadership and Management	29	16.5	16.5	65.3
Bachelor of Arts in Communication	18	10.2	10.2	75.6
Bachelor of Arts in Community Development	29	16.5	16.5	92.0
Bachelor of Commerce	3	1.7	1.7	93.8
Diploma in Business Management	11	6.3	6.3	100.0
Total	176	100.0	100.0	

A sample size of 176 (36.34%) was selected and considered adequate for the study since it is a descriptive study that targeted a confidence level of 95% or a margin of error of 5%. The minimum sample required in this case is 175 respondents. Table 1.1 shows the sample selected per programme of study. The unit of the study was the distance learning student and therefore all students were considered as one target group irrespective of the programme and the year of study.

Research Instruments and Data Collection Procedures

A questionnaire for the students was used in this study. The questionnaire had closed ended and open-ended items. The closed-ended items solicited specific information while the open-ended sought for respondent's own opinions, views and experiences. Data was collected by distributing the questionnaires to students through the MOODLE e-learning system. The study was mainly interested in mobile phone self-efficacy and utilization by the respondents and thus a questionnaire was considered appropriate for gathering the required data since it would help to get the required data for the study. The validity of the instruments was evaluated through expert evaluation by experienced lecturers who have used the POODLE and MOODLE Leaner Management systems and actual administration of the instruments to a pilot group of 10 distance learning students. Unclear and ambiguous items were corrected or removed and where necessary others were added. Reliability of the instruments was tested through the split-half method. The Kuder-Richardson formula (KR20) was applied to determine the reliability of the questionnaire since most of the items were dichotomously scored. The reliability achieved is as indicated in table 1.2.

Table 1.2 Split Half Reliability (r_{tt}) Analysis

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.771	.750	79

A reliability level of 0.771 was obtained as shown in table 1.2. This level of reliability was considered adequate for the study. Babbie, Halley and Zaino (2003) and Gibbon and Morris (1987) indicate that a reliability (r_{tt}) level of 0.60 is adequate for a test while Fraenkel and Wallen (2009) recommend a reliability coefficient of at least 0.7 or above.

Quantitative data from the questionnaires was analyzed by use of descriptive statistics in form of frequencies, percentages and Pearson Chi-Square(x^2) at a set significance level of ($p < .05$) and presented in form of tables. Chi-Square was selected since the data obtained was mainly at nominal and ordinal levels. Qualitative data was coded and the response on each item was put into specific main themes. Thereafter frequencies, percentages and chi-square were calculated for each theme and presented in form of tables. Some of the respondents' responses were reported verbatim.

Results

Distance Learning Students' Gender, Age and Year of Study Results

The essence of the respondents' gender, age and year of study data was to relate the three variables to the distance learning students' mobile phone level of utilization and self-efficacy for learning. The results on respondents' gender, age and year of study are as shown in tables 1.3, 1.4 and 1.5, respectively.

Table 1.3 Distance Learning Students Gender

	Frequency	%	Valid %	Cumulative %
Male	69	39.2	39.2	39.2
Female	107	60.8	60.8	100.0
Total	**176**	**100.0**	**100.0**	

Table 1.3 shows that 39.2 % of the respondents were male while 60.8 % were female. This indicates there are almost one and half times more female than male distance learning students at St. Paul's University and agrees with actual statistics of all distance learning students at the university.

Tables 1.4: Distance Learning Students' Year of Study

	Frequency	%	Valid %	Cumulative %
18-25 years	13	7.4	7.4	7.4
26-35 years	85	48.3	48.3	55.7
36-45 years	56	31.8	31.8	87.5
46-55 years	14	8.0	8.0	95.5
56 years and Above	8	4.5	4.5	100.0
Total	**176**	**100.0**	**100.0**	

From Table 1.4 it is clear that majority of the respondents 48.3% were between 26-35 years of age, followed by the 36-45 years at 31.8%. The least were those of 56 years and above at 4.5% of the sample. Thus, one can conclude that most of the distance learning students at St. Paul's University are the youth and middle aged.

Table 1.5: Distance Learning Students' Year of Study

	Frequency	%	Valid %	Cumulative %
Year 1	49	27.8	27.8	27.8
Year 2	41	23.3	23.3	51.1
Year 3	31	17.6	17.6	68.8
Year 4	55	31.3	31.3	100.0
Total	**176**	**100.0**	**100.0**	

Table 1.5 indicates that majority of the respondents were in year four of their studies at 31.3%, followed by year one students and year two students at 27.8% and 23.3% respectively. The least were year three students at 17.6 % of the sample. Thus, one can conclude that the total number of distance learning students in all the four years apart from year three are relatively close.

Distance Learning Students Level of POODLE Mobile Phone Application Utilization

Each of the respondent was asked to indicate the type of a mobile phone he/she uses. This was necessary in order to determine the number of distance learning students who can access the POODLE software considering that it requires the use of an Android smartphone. The results on the mobile phone used by the respondents are as indicated in table 1.6.

Table 1.6: Type of Mobile Phone used by Distance Learning Students

	Frequency	%	Valid %	Cumulative %
Smart phone	175	99.4	99.4	99.4
Ordinary Phone	1	.6	.6	100.0
Total	**176**	**100.0**	**100.0**	

Table 1.6 shows that most of the students 99.4 % (175) use a smartphone and thus they can access the POODLE application. Only one student or 0.6 % uses an ordinary phone. These findings illustrate that most students were in a position to access the POODLE application since almost all of them had a smartphone.

A cross tabulation to find out the association between the students' gender and the use of the POODLE application was done and the results are as indicated in tables 1.7 and 1.8 .

Table 1.7: Distance Learning Students' Gender and Use of POODLE Application

		Respondents Gender		Total
		Male	Female	
Have Used	Count	46	58	104
	% within Respondents Gender	66.7%	54.2%	59.1%
	% of Total	26.1%	33.0%	59.1%
Have not Used	Count	23	49	72
	% within Respondents Gender	33.3%	45.8%	40.9%
	% of Total	13.1%	27.8%	40.9%
Total	Count	69	107	176
	% within Respondents Gender	100.0%	100.0%	100.0%
	% of Total	39.2%	60.8%	100.0%

Table 1.8 Distance Learning Students' Gender and Use of POODLE Application

Chi-Square Results

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.695[a]	1	.101		
Continuity Correction[b]	2.204	1	.138		
Likelihood Ratio	2.723	1	.099		
Fisher's Exact Test				.117	.068
Linear-by-Linear Association	2.679	1	.102		
N of Valid Cases	176				

Table 1.7 indicates that comparatively male students used the POODLE more at 66.7% than the female students at 54.2% while 45.8% of the female students had not used the application compared to 33.3 % of the male students. However, the Chi-square obtained (x^2 (1) = 2.695, p < .05) as indicated in table 1.8 was not significant. Therefore, though male students used the POODLE application more than the female students, there is no significant relationship between students' gender and the use of POODLE application. However, the non-utilization of the POODLE application may be due to the fact that it can only downloaded in an android system based mobile phone.

The results for cross tabulation between the students' year of study and the use of POODLE application is as indicated in tables 1.9 and 1.10

Table 1.9 Distance Learning Students Year of Study and Use of POODLE Application

			Respondents Year of Study				Total
			Year 1	Year 2	Year 3	Year 4	
Total	Have Used	Count	29	24	18	33	104
		% within	59.2%	58.5%	58.1%	60.0%	59.1%
		% of Total	16.5%	13.6%	10.2%	18.8%	59.1%
	Have not Used	Count	20	17	13	22	72
		% within	40.8%	41.5%	41.9%	40.0%	40.9%
		% of Total	11.4%	9.7%	7.4%	12.5%	40.9%
		Count	49	41	31	55	176
		% within	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	27.8%	23.3%	17.6%	31.2%	100.0%

Table 1.10 Distance Learning Students Year of Study and Use of POODLE Application Chi-Square Results

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.038[a]	3	.998
Likelihood Ratio	.038	3	.998
Linear-by-Linear Association	.007	1	.935
N of Valid Cases	176		

Table 1.9 shows that fourth years used the POODLE application more at 60% within the group and 18.8% of all the students. They are followed by first years with 59.2% within the group and 16.5% of all the students. The least group that used the application are the third years with 58.1% within the group and 10.2% of all the students. Table 1.10 shows that the Chi-square obtained (x^2 (1) = 0.38, p < .05) was not significant. Therefore, is no significant relationship between students' year of study and the use of POODLE application. Tables 1.7 and 1.10 show that 40.9 % of the students do not use the POODLE application. This is significant since the aim of developing the application and its implementation was to increase the use of e-learning by distance learning students and make it flexible. This is in view of the fact that 99.4% of the students as indicated in table 1.6 have smartphones and therefore are capable of downloading and using it. However, as noted earlier the non-utilization may partly be explained by the fact that it can only be used in an android system based mobile phone.

The results for the relationship between students' age bracket and use of POODLE application are as indicated in tables 1.11 and 1.12

Table 1.11 Distance Learning Students Age and Use of POODLE Application

		Respondent's' Age					Total
		18-25 years	26-35 years	36-45 years	46-55 years	56 years and Above	
Have Used	Count	7	56	29	9	3	104
	% within	53.8%	65.9%	51.8%	64.3%	37.5%	59.1%
	% of Total	4.0%	31.8%	16.5%	5.1%	1.7%	59.1%
Have not Used	Count	6	29	27	5	5	72
	% within	46.2%	34.1%	48.2%	35.7%	62.5%	40.9%
	% of Total	3.4%	16.5%	15.3%	2.8%	2.8%	40.9%
Total	Count	13	85	56	14	8	176
	% within	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	7.4%	48.3%	31.8%	8.0%	4.5%	100.0%

Table 1.12 Distance Learning Students Age and Use of POODLE Application Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.705[a]	4	.319
Likelihood Ratio	4.689	4	.321
Linear-by-Linear Association	1.438	1	.231
N of Valid Cases	176		

Table 1.11 shows that students between 26-35 years had the largest number of POODLE application users at 65.9% followed by the 46 -55 year and 18-25-year-old students at 64.5% and 53.8% respectively. 56 years and above year-old students had the largest comparative number of students that did not use the application at 62.5%. The Chi-square obtained (x^2 (4) = 4.705, p < .05) as recorded in table 1.12 is not significant and thus the relationship between the students' age and use of the POODLE application is not significant.

When asked to indicate the reason for not using the POODLE Application the students' responses were as indicated in table 1.13.

Table 1.13 Distance Learning Students Responses on Reasons for Not Using the POODLE Application

Reason		Male		Female		Total	
		Frequency n=69	% 100	Frequency n=107	% 100	Frequency n=176	% 100
I have not downloaded the POODLE application	**Yes**	23	33.3	44	41.1	67	38.1
	No	46	66.7	62	57.9	108	61.4
Lack of skill in using the POODLE application	**Yes**	2	2.9	10	9.3	12	6.8
	No	67	97.1	97	90.7	164	93.2
I don't know about the POODLE application	**Yes**	10	14.5	25	23.4	35	19.9
	No	59	85.5	82	76.6	141	80.1
POODLE App. not accessible & compatible with my phone	**Yes**	18	26.1	32	29.9	50	28.4
	No	51	73.9	75	70.1	126	71.6
Phone fonts and interface too small to clearly see	**Yes**	1	1.4	1	0.9	2	1.1
	No	68	98.6	106	99.1	174	98.9

From table 1.13 it is clear the main reason for students not using the POODLE application was not downloading the application with a 41.1 % of the female students and 33.3% of the male students. This perhaps explains the findings in tables 1.8 and 1.11 where 40.9 % of the students indicated that they do not use the POODLE application. The least

reason was phone fonts and interface too small to be seen clearly with one student in each gender or 1.4 % and 0.9 % of the male and female students, respectively.

Distance Learning Students Self-Efficacy in Utilization of the POODLE Application

The second objective of the study was to find out distance learning students' self-efficacy in utilization of the POODLE application. In order to test this, respondents were asked to indicate whether they have skills in the use of the POODLE application. The results on comparison between gender, year of study and age are presented in the subsequent tables below.

Table 1.14 Distance Learning Students' Gender and Self-Evaluation on Skills Needed in the Use of POODLE Application

		Respondents' Gender		Total
		Male	Female	
I have Skills in the Use of POODLE	Count	63	97	160
	% within Respondents Gender	91.3%	90.7%	90.9%
	% of Total	35.8%	55.1%	90.9%
I Don't have Skills needed in the Use of POODLE	Count	6	10	16
	% within Respondents Gender	8.7%	9.3%	9.1%
	% of Total	3.4%	5.7%	9.1%
Total	Count	69	107	176
	% within Respondents Gender	100.0%	100.0%	100.0%
	% of Total	39.2%	60.8%	100.0%

Table 1.15 Distance Learning Students' Gender and Self-Evaluation on Skills Needed in the Use of POODLE Application Chi-Square Results

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.021[a]	1	.884		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.022	1	.883		
Fisher's Exact Test				1.000	.555
Linear-by-Linear Association	.021	1	.884		
N of Valid Cases	176				

Table 1.14 shows most students indicated that they have skills in the use of the POODLE Application with male students leading with 91.3% and female students following closely with 90.7%. The Chi-Square results obtained in table 1.15 (X^2 (1) = 0.021, $p<.05$) indicate that there is no significant relationship between the students' gender and their self-evaluation on skills needed in the use of the POODLE application.

Table 1.16 Distance Learning Students' Year of Study and Self-Evaluation on Skills Needed in the Use of POODLE Application

		Respondents' Year of Study				Total
		Year 1	Year 2	Year 3	Year 4	
I have Skills in the Use of POODLE	Count	48	39	28	45	160
	% within Respondents Year	98.0%	95.1%	90.3%	81.8%	90.9%
	% of Total	27.3%	22.2%	15.9%	25.6%	90.9%
I Don't have Skills needed in the Use of POODLE	Count	1	2	3	10	16
	% within Respondents Year	2.0%	4.9%	9.7%	18.2%	9.1%
	% of Total	0.6%	1.1%	1.7%	5.7%	9.1%
Total	Count	49	41	31	55	176
	% within Respondents Year	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	27.8%	23.3%	17.6%	31.2%	100.0%

Table 1.17 Distance Learning Students' Year of Study and Self-Evaluation on Skills Needed in the Use of POODLE Application Chi-Square Results

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.340[a]	3	.025
Likelihood Ratio	9.619	3	.022
Linear-by-Linear Association	8.881	1	.003
N of Valid Cases	176		

Data presented in table 1.16 shows that distance learning students had varied self-evaluation on skills needed in the use of POODLE application. First, second, third and fourth years had 98.0%, 95.1%, 90.3% and 81.8% respectively. Few students across the years indicated that they did not have skills needed in the use of the application. The highest percentage was with the fourth years at 5.7%. The Chi-square results presented in table 1.17 (X^2 (3) = 9.340, P<.05) indicate a significant relationship between distance learning students' year of study and their self-evaluation on skills needed in the use of POODLE application.

Table 1.18 Distance Learning Students' Age and Self-Evaluation on Skills Needed in the Use of POODLE Application

		Respondents' Age Bracket					Total
		18-25 years	26-35 years	36-45 years	46-55 years	56 years and Above	
I have Skills in the Use of POODLE	Count	11	82	49	12	6	160
	% within Respondents' Age	84.6%	96.5%	87.5%	85.7%	75.0%	90.9%
	% of Total	6.2%	46.6%	27.8%	6.8%	3.4%	90.9%
I Don't have Skills needed in the Use of POODLE	Count	2	3	7	2	2	16
	% within Respondents' Age	15.4%	3.5%	12.5%	14.3%	25.0%	9.1%
	% of Total	1.1%	1.7%	4.0%	1.1%	1.1%	9.1%
Total	Count	13	85	56	14	8	176
	% within Respondents' Age	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	7.4%	48.3%	31.8%	8.0%	4.5%	100.0%

Table 1.19 Distance Learning Students' Age and Self-Evaluation on Skills Needed in the Use of POODLE Application Chi-Square Results

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.499[a]	4	.112
Likelihood Ratio	7.434	4	.115
Linear-by-Linear Association	3.343	1	.067
N of Valid Cases	176		

Table 1.18 shows there were varied differences on students' age and their self-evaluations on skills needed in the use of the POODLE application. 96.5% of the 26-35-year-old students indicated that they had the skills needed in the use of POODLE application followed by 36-45-year olds with 87.5% 46-55-year olds at 85.7%, 18-25-year olds with 84.6% and 56 years and above at 75% respectively. The Chi-Square obtained though high as shown in table 1.19 ($X2\ (4) = 7.499$, $p<.05$) was not significant and thus there is no significant relationship between distance learning students' age and their self-evaluation on the skills needed in the use of the POODLE application.

On being asked whether they need training in the use of the POODLE application respondents had the responses as noted in table 1.20.

Table 1.20 Distance Learning Students' Responses on the Need for Training in the Use of the POODLE Application.

		Respondents' Gender		Total
		Male	Female	
I Need Training	Count	34	55	89
	% within Respondents' Gender	49.3%	51.4%	50.6%
	% of Total	19.3%	31.2%	50.6%
I don't Need Training	Count	35	52	87
	% within Respondents' Gender	50.7%	48.6%	49.4%
	% of Total	19.9%	29.5%	49.4%
Total	Count	69	107	176
	% within Respondents' Gender	100.0%	100.0%	100.0%
	% of Total	39.2%	60.8%	100.0%

Table 1.20 shows that 50.6% of the distance learning students indicated they need training. This is despite the fact that 90.9% as noted in tables 1.16 and 1.18 showed that they have the skills required in using the POODLE application. This is perhaps because some of those who had indicated they have skills in the use of the POODLE application may still feel the need for refresher training in the use of the application.

The students were asked to indicate whether they have experienced challenges in the use of the POODLE application. Their responses are as indicated in table 1.21.

Table 1.21 Distance Learning Students' Responses on whether they have Experienced Challenges in the use of the POODLE Application.

		Respondents' Gender		Total
		Male	Female	
I have Experienced Challenges in Using the POODLE	Count	46	76	122
	% within Respondents' Gender	66.7%	71.0%	69.3%
	% of Total	26.1%	43.2%	69.3%
I have not Experienced Challenges in Using the POODLE	Count	23	31	54
	% within Respondents' Gender	33.3%	29.0%	30.7%
	% of Total	13.1%	17.6%	30.7%
Total	Count	69	107	176
	% within Respondents' Gender	100.0%	100.0%	100.0%
	% of Total	39.2%	60.8%	100.0%

Considering the findings 1.21 one can deduce that majority of the students (69.3%) had challenges in the use of the POODLE application and perhaps this partly explains the poor usage as recorded in table 1.11. Students were asked to indicate specific challenges they have faced in the use of the POODLE application. Their responses are as indicated in table 1.22.

Table 1.22 Challenges Faced by Distance Learning Students in their use of the POODLE Application

Challenge		Male		Female		Total	
		N= 69	% 100	N= 107	% 100	N	%
Failure & Malfunction of the POODLE Application	Yes	44	63.7	67	62.7	111	63.1
	No	25	36.2	40	37.4	65	36.9
Non-Compatibility of the POODLE Application with my Mobile Phone.	Yes	31	44.9	54	50.5	85	48.3
	No	38	55.1	53	49.5	91	51.7
Non-Accessibility of the POODLE Application	Yes	27	39.1	48	44.9	75	42.6
	No	42	60.9	59	55.1	101	57.4
Lack of Skill in the Use of the POODLE Application	Yes	3	4.3	7	6.5	10	5.7
	No	66	95.7	100	93.5	166	94.3
Challenge		**Male**		**Female**		**Total**	
		N= 69	**% 100**	**N= 107**	**% 100**	**N**	**%**
Data Displayed in Small Fonts that are Difficult to Read	Yes	5	7.2	6	5.6	11	6.2
	No	64	92.8	101	94.4	165	93.8
Malfunction & Breakdown of the Mobile Phone	Yes	20	29	37	34.6	57	32.4
	No	49	71	70	65.4	119	67.6
Did not Know about the POODLE Application	Yes	2	2.9	5	4,7	7	4
	No	67	97.1	102	95.3	167	96
Slow, Unstable & Non-availability of Internet	Yes	34	49.3	58	54.2	92	52.3
	No	33	47.8	43	44.9	81	46

As noted in table 1.22, failure and malfunction of the POODLE application is the greatest challenge pointed out by distance learning students with 63.1% followed by Slow, unstable & non-availability of Internet at 52.3% and non-compatibility of the POODLE application with the mobile phone that had 48.3%. The least challenge as noted by students is lack of knowledge on the existence of the POODLE application at 4%. The second least challenge is lack of

skill in the use of the POODLE application with 5.7%. Data displayed in small fonts that are difficult to read is the third least challenge with 6.2%. The greatest challenges on failure and malfunction of the POODLE application and Slow, unstable & non-availability of Internet may explain the poor usage of the POODLE as noted in table 1.11.

Discussions

The purpose of this study was to find out distance learning students' mobile phone self-efficacy and utilization for learning. The first objective was to assess the level of POODLE mobile phone application utilization by distance learning students at St. Paul's University. The findings obtained indicated that comparatively more male distance learning students used the POODLE application than their female colleagues. The use of the application by the students was slightly above average. A significant number of slightly less than half had not used the application. In terms of the use of the application in relations to the year of study, there were only slight variations. Fourth years led the group followed by first, second and third years in that order. The results also indicated that students between 26-35 years were users of POODLE application, followed by those between 46 -55 years, 18-25 years and 56 years and above. The latter had the largest comparative number of students that did not use the application. Data obtained showed minimal differences in the use of the POODLE application in relation to gender, age and year of study. There were slight variations on the number of times the distance learning students in relation to gender, age and year of study though there was no significant relationship between the three variables and the number of times the students used the POODLE application.

This difference is perhaps explained by some cases where some students indicated that at one point they had uploaded the application and used it but later they could not access it as seen in the words of two of the students below.

"*Sometime back l downloaded the up but when I tried accessing my student account it wasn't going through." (Brenda)*

"Year 1 I used the app and it worked so well but since the beginning of this year I haven't used it because when I try to open the app it displays an error that says I should check that my site uses Moodle 2.4 or later and I don't know what that means." (Alice)

These findings clearly prove that the use of the POODLE application is not satisfactory since only slightly more than half of the distance learning students use it. Out of the students who had not used the POODLE application, most indicated that they had not downloaded it and cited non-compatibility of the application with their phones. These two reasons can perhaps be further explained by the statements of some of the students as cited below.

"My Phone had some break down leading to difficulties in downloading the poodle" (Daniel)

"Sometimes am unable to log in -Versions change and one cannot download it" (John)

"It cannot be downloaded on my phone. I don't know what the problem is, but I think my phone is not compatible" (Mary)

Lack of utilization of the POODLE application by almost half of the distance learning students defeats the intentions of developing it which were to; increase the use of the LMS and make it more accessible and flexible for the distance learning students. Even though there were no significant relationships between the use the POODLE and gender, and age, it nevertheless indicates some differences that need to be addressed during development and implementation of mitigation strategies.

The second objective of the study was to find out distance learning students' self-efficacy in utilization of the POODLE mobile phone application in learning. The findings obtained demonstrate that most of the students indicated that they had the skills required in the use of the POODLE application. Male students had a slightly higher percentage than the female students in this case. In terms of the relationship between year of study and the students self-evaluation on the skills needed in the use of the POODLE application, results of the study show a significant relationship between the two variables. All the levels of study had higher percentages of over eighty percent led by the first, second, third and fourth years in that order. It thus follows that majority of the St. Paul's University distance learning students have positive POODLE mobile phone application self-efficacy. The positive self-efficacy of the student can be explained and summed up by the statements from the following students.

"I have been using mobile phone since 2003 and with ICT knowledge I find it easy to work with e-learning applications using my phone" (John).

"I use a computer in my daily routine of work and I have proper training skills on most of its applications" (Wanza)

"It is easy to use the mobile app because it is the same as the e-learning portal" (Muasa)

However, it is good to note that slightly over half of all the students indicated that they need training in the use of the POODLE application. This is despite the fact that over ninety percentage had indicated they have the required skills. This may be because even some of those who had indicated they have skills in the use of the POODLE application felt that they still need refresher or more training in the use of the application as noted in the views of the following students.

"I think I need to advance the skills and techniques required" (Wambui).

"I find out that I still learns (sic) something new every time am using this platform" (Kirui)

"I think I just know an 1/8 of what am supposed to know, because I haven't mastered all the areas" (John)

"My wish is to learn more about the poodle so that I can effectively use in my l learning" (Ng'endo)

Based on the results of this study, we can conclude that the use of the POODLE application is not satisfactory since only slightly more than half of the distance learning students use it. The study also concludes that even though there are no significant differences between the use of the POODLE and gender, age and year of study the differences observed should be considered in developing mitigation strategies. The study also concludes that even though use of the POODLE application was not satisfactory, majority of the distance learning students at St. Paul's University, indicated they had the required skills in the use of the application thus showing a positive POODLE mobile phone application self-efficacy. Adedoja and Oluwadara (2016), Isman and Celikli, (2009), Aremu and Fasan (2011) and Chia-Pin & Chin-Chung (2009) all point out that self-efficacy is a fundamental factor in the adoption and use of a technology. The positive self-efficacy is a good sign that may lead to full adoption of the POODLE application by St. Paul's University distance learning students if the challenges highlighted are effectively delt with.

There was no significant relationship between students' gender, age and their self-evaluation on whether they have the skills in the use of POODLE application. However, male students had a slightly higher percentage than the female colleagues. However, the results of the study showed a significant relationship between the distance learning students' year of study and the students' self-evaluation on whether they have the skills in the use of POODLE application. The study recommends regular training, sensitization on POODLE application to all students and re-engineering and regular updates of the application to make it more stable with less or no malfunctions. Additionally, a follow up study is recommended to ascertain the extent to which the POODLE application has been utilized by distance learning students for learning and whether their mobile phone self-efficacy has improved particularly during the COVID-19 pandemic period which was highly characterized by closure of universities as teaching and learning was moved online.

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Inquiry Learning in Secondary School Biology – Do Biology Teachers Possess the Relevant Pedagogical Competencies?

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Abstract

With the rapid changes in technology in the present world, Kenya as a nation cannot afford to remain behind. To keep abreast with the changes, the government through the Ministry of Education has made changes in the curriculum with an emphasis on Science, Technology, Engineering and Mathematics (STEM). This is to ensure that students graduating from the secondary level of education possess the necessary scientific process skills. This is essential to meet societal needs and achieve the Vision 2030. Inquiry Learning has been found to be most effective and efficient in acquisition of science process skills. For the students to acquire the knowledge and the scientific process skills, it is required that Biology educators possess certain pedagogical competencies. However, according to most research findings, science educators tend to agree that the teaching methods used in secondary schools are still teacher – centred and not student – centred. This does not encourage students to achieve lifelong learning and application. A desk research was performed to evaluate if biology teachers possessed the pedagogical competencies necessary for inquiry learning. This study examined secondary data from the internet and the library on the Biology teachers' pedagogical competencies. The study documented different approaches used by Biology teacher. The study established that Biology teachers did not use inquiry method to the required extent as documented in the teachers' guides and syllabus. The major factors documented to be hindering the use of inquiry method, were lack of resources and equipment, inadequate time to cover the syllabus, poor teacher preparation and inadequate qualified biology teachers.

Keywords*: Inquiry Learning, Pedagogical Competencies, Science Process Skills.*

Introduction

Humans, especially children, are naturally inquisitive especially in early stages of their development (National Research Council, 2000). The exploratory behaviour is manifested in play, curiosity and reaction to strangers. This has been noted by behaviorists, biologists, baby biographers and psychologists (Eleanor, 1988). Research has shown that with proper nurturing and engaging learners in open-ended exploration, they develop a wide range of abilities such as the skill of creativity and the ability to communicate their understanding of the world with confidence (Saskatchewan Ministry of Education, 2008).

Ferrant (2006) defined learning as the process by which an individual acquires and retain attitudes, knowledge, understanding, skills and capabilities that cannot be attributed to innate behavior patterns or physical growth. According to Farrat, the efficiency and effectiveness of the learning process largely depends on the approach used by the teacher. The approaches also influence the extent to which the acquired skills and knowledge will be applied by the leaner in future.

According to Wanjala et al. (2019), there are two broad learning approaches in Biology: surface learning and deep learning. In surface learning, the learner is exposed to low- cognitive activities. Such learners at the end of a given experience can hardly acquire the intended skills and knowledge hence cannot apply them. Surface learning is characterized by memorization of content and copying notes from text books (ibid). The teacher's intention is normally to complete the syllabus regardless of the objectives of the Biology curriculum. In most instances, students normally develop a negative attitude towards Biology as a subject leading to low achievement in national examinations.

In deep learning approach, according to Wanjala et al, the Biology teacher uses appropriate learning activities that engage students in high-level cognition. The learners develop a holistic understanding of Biology and can easily apply the skills and knowledge acquired. According to him, deep learning activities include: theorizing, applying knowledge to new situations, explaining, raising questions, hypothesizing and giving alternative ideas. To achieve the Biology curriculum objectives, Biology tutors should use learning and teaching approaches that encourages deep learning. One such approach is the inquiry-based learning. Inquiry-based learning was developed in the 1960s although many teachers see it as a new pedagogy, which implies that they have questions about how to use it and if it is worthwhile (Marcus, 2017).

According to National Research Council, (2000), "Inquiry" refers to the diverse ways in which scientists study the natural world and in which students grasp science knowledge and the methods by which that knowledge is produced. From a student's point-of-view, inquiry-based learning focuses on investigating an open question or problem. They use evidence-based reasoning and creative problem-solving to reach a conclusion, which they must defend or present. On the other hand, from a teacher's point-of-view, inquiry-based teaching focuses on moving students beyond general curiosity into the realms of critical thinking and understanding (Marcus, 2017). The aim of inquiry-based science education is to help pupils develop scientific skills and a deep understanding of the subject matter and the nature of science and to them to utilize

evidence from the real world to address contemporary societal challenges (Alake et al., 2012).

Inquiry learning approach which seeks to train learners in the techniques of how to obtain information that they need, normally enhances deep learning. This is different from the concept of teaching as a process by which a body of knowledge is transferred from the teacher to the learner (Farrant, 2006). Farrant suggests that to have a successful inquiring learning process, there should be structured learning situations to lead the learner a long a particular line of thought or into a new experience. In this process, usually students are not aware of the planning that lies behind the discoveries they make for themselves. Learners are encouraged to work in collaboration, to be creative, to think critically and to faithfully communicate their findings. This kind of learning produces learners who are problem solvers in society, which is the ultimate aim of the education system of any given country. To use inquiry approach successfully, the Biology teacher should possess certain competences. According to Vikstro¨m (cited in Alake et al., 2012), teachers' competencies influence pupils' learning. Mulder (cited in Alake et al., 2012) observed that some of the personal competencies a teacher should possess comprise of integrated performance-oriented capabilities. These capabilities consist of clusters of knowledge structures, cognitive, interactive, effective and where necessary psychomotor capabilities, attitudes and values. These capabilities are required for carrying out tasks, solving problems, and more generally effectively functioning in a certain profession, organization, position or role.

In the inquiry approach, teachers acknowledge and enhance the learners' abilities. They purposively plan to polish the skills and knowledge acquired by the learners. This type of approach to learning is opposed to the traditional one in which recipe kind of practical work is conducted after learning a concept.

Extent to which Biology Teachers Use Inquiry Method in Secondary Schools

Biology is a science, and for effective teaching and learning, the biology teachers should expose learners to as many practical activities as possible. Practical work and projects assist in making abstract concepts concrete. William et al., (2019) opine that the teacher's role is to choose problems that can be solved in different ways and which have the capacity to probe student's thinking as they discuss problem approaches. This calls for Biology teachers to be good planners.

An analysis of the Kenyan secondary biology syllabus and biology course books reveal that for every topic, many practical and project activities are suggested which if well planned and executed, will lead to the development of inquisitive skills and high interest in the learning of biology by both learners and teachers.

The Ministry of Education through various agencies like Strengthening Mathematics and Science Education (SMASE) has been emphasizing that science teachers embrace inquiry approach in the teaching of sciences in schools. In spite of the emphasis, research indicates that, the teaching and learning of biology in many secondary schools in Kenya is predominantly teacher-centred (Wamukota et al., 2017).

Teaching in an inquiry manner, results in students learning science in a way that expresses more accurately the nature of science. It may also bring about conceptual changes in students' minds not only effectively but also permanently (Trowbridge et al., 2004). On the other hand, teacher centred approach, does not enhance learners' conceptual understanding. This makes the teaching and learning of biology boring leading to negative attitude towards the subject (William et al., 2019). The end result is underperformance in the Biology national examinations and non-acquisition of the intended skills.

Phases of Inquiry Based Learning

According to Pedaste et al., 2015, there are generally five phases of inquiry-based learning: Orientation, Conceptualization, Investigation, Conclusion, and Discussion. During orientation phase, the learner's curiosity about a topic is stimulated and a problem statement formulated. In conceptualization phase, research questions or hypotheses based on the stated problem are generated. Investigation phase on the other hand involves planning of exploration or experimentation, collecting and analyzing data based on the experimental design or exploration. Under the conclusion phase, inferences are drawn basing on the data collected. Finally, the discussion phase entails presentation of findings of particular phases of the whole inquiry cycle and communicating with other learners.

According to Trowbridge et al., 2004, science teachers should allow learners to formulate usable questions, plan experiments, conduct systematic observations, analyze data, do interpretation, draw conclusions, communicate their findings, coordinate and implement their findings. This approach ensures that students acquire different skills for example: psychomotor skills, setting up of apparatus, making observations, measuring, recording data, analyzing of data, and communication amongst other scientific skills (Trowbridge, 2004).

Statement of the Problem

The four pillars of education advocated by UNESCO form the core goal of teaching and learning of Biology in Kenya. These are: learning to know, learning to do, learning to live together and learning to be (Wanjala et al., 2019). This is also well stated in the ten general objectives of learning Biology at the secondary level in Kenya. Biology is a precursor of Biotechnology which is a tool for industrial, technological and applied fields like Health, Agriculture, Environment and Education (Kenya Institute of Curriculum Development, 2002).

Due to the immense importance of Biology in the improvement of the welfare of humankind, several initiatives have been put in place to improve its teaching and learning. Amongst the initiatives is the adoption of twenty first century pedagogical approaches. In spite of the elaborate initiatives, majority of biology teachers still use traditional methodologies which do not foster the learning of science in a manner that can make students express and apply the skills and knowledge learnt in biology.

Given that the skills and knowledge learnt in biology play an important role in understanding the natural world around us and how to make use of it in a sustainable manner for the betterment of humankind, it is necessary to investigate the extent to which biology teachers have adopted the use of the inquiry method of teaching.

Methodology

The research was carried out as a desk study. The literature review was designed basically as a descriptive study to provide information on the situation about the teaching and learning of biology in Kenyan secondary schools. The information in this study was sourced from various secondary sources all listed in the reference list. It is important to note that this report is not a comprehensive review of the available literature on the topic.

Results

The purpose of this study was to determine if Biology teachers possess pedagogical competencies required for inquiry learning. Katz et al., and Lee et al., (as cited in Alake et al. 2012) observed that teachers cannot teach what they do not understand. Teachers therefore, need accurate and comprehensive mastery of science content and appropriate pedagogic competencies in order to teach science successfully. A closer scrutiny of data from research that have been conducted relating to pedagogies used by biology teachers in Kenya revealed that a significant percentage of them were not using the inquiry approach. This could be an indicator that majority of Biology teachers lack the appropriate competencies required for inquiry learning.

Omufwoko et al., (2020) found out that the least pedagogies used by student teachers were: Problem Solving Activities, Project Work, Excursions/ Field Work and 5E learning method. Project work gives learners an opportunity to grasp biological content and master concepts on their own with the teacher as a guide. It also helps them internalize methods used by scientists to create new knowledge. Omufwoko also established that majority (80%) of student teachers preferred traditional pedagogies. These findings could be an indicator that majority of student teachers had inadequate competencies to enable them use inquiry-based learning. These findings could be an indicator that the problem of incompetency in the use of inquiry learning in secondary schools could be emanating from teacher training.

Wamukota et al., (2017) opined that pedagogies which encourage inquiry learning like field trips/field excursions are rarely used and that in some schools had never been used. The lecture method dominated the teaching in the learning of Biology. Owiti et al., (2014) in their research found out that 75% of biology teachers used lecture and demonstration approaches and that projects and problem solving which stimulate high level of learning in students were rarely used. Otieno, (2013) found out that SMASSE trained Biology teachers ensured their lessons were student-centred by use of group discussions and demonstrations. However, the same study indicated that field excursions were rarely used in the teaching of Biology and that students were rarely involved in the planning of practical work. This denied learners the opportunity to learn the scientific method of creating knowledge.

Discussion

From the findings, it is evident that majority of Biology teachers in Kenyan secondary schools do not use inquiry approaches in the teaching of Biology. These findings concur with Nwagbo (cited in Omufwoko et at. (2020) who opines that in many schools, teachers usually shy away from more effective activity-oriented teaching methods in preference to traditional approaches that are teacher–centred.

This is a threat not only to keeping abreast with the rapid changes in Science and Technology but also to achieving of Vision 2030. This underscores the need for equipping teachers with the necessary competencies for using inquiry approach. This is consistent with the views of Alake et al., (2012) who observed that good-quality teachers, with up-to-date knowledge and skills, are the foundation of any system of formal science education.

The Biology curriculum encourages the use of inquiry approach throughout the secondary cycle of education. The Kenya Institute of Curriculum Development, (2017) observed that the use of learner- centred pedagogies to teach, enable learners acquire learning skills essential to mastering material in a discipline. Also, that research has consistently confirmed that learning skills develop faster if they are taught explicitly along with the content. This view is supported by Howes et al., (as cited in Alake, et al., (2012) who noted that the aim of inquiry-based science education is to help pupils develop scientific skills and a deep understanding of the subject matter and the nature of science. They also observed that it encourages pupils to ask questions and aid them in learning to utilize evidence from the real world to address these questions.

There is need for Biology teachers to adopt the 21st century teaching approaches such as inquiry-based learning to enable learners acquire the 21st century skills. Wanjala et al., (2019) supports this view by suggesting that Biology teachers should use appropriate inquiry approach in teaching to enable learners develop a holistic understanding of Biology and easily apply the skills and knowledge acquired. The learning activities should include: theorizing, applying knowledge to new situation, explaining, raising questions, hypothesizing and giving alternative ideas.

Farrant (2006) echoes the same by stating that if inquiry learning is well structured, it enhances the acquisition of collaboration, creative, critical thinking and communication skills. This kind of learning produces problem solvers in the society.

Conclusion

From the research findings, the authors established that inquiry-based learning is rarely used by Biology teachers in Kenyan secondary schools and that recipe like experiments are done after covering topics. This was attributed to: in adequacy of resources, pressure to complete the syllabus within the timeframe set by school administration, teacher incompetence and low entry behaviour of students. In addition to the above causes, the main reason for not using inquiry learning approach by Biology teachers could be attributed to the lack of the competencies required.

The following recommendations are suggested to enhance inquiry-based learning:

Effective and efficient in-service INSETs should be offered to biology teachers

Collaboration should be encouraged amongst biology teachers to foster sharing of knowledge

Each biology teachers should have an instructional theory to enable them be efficient.

Biology teachers should be conversant with the national educational goals and biology subject curriculum goals.

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Influence of Teachers' Instructional Strategies and Students' Learning Styles on Process Skills Acquisition in Secondary School Physics in Kenya

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Abstract

This study investigated the influence of teachers' instructional strategies and students' learning styles on students' acquisition of science process skills in physics among Kenyan secondary school students. A pre-test post–test quasi–experimental non-equivalent control group design was used. The investigation involved three teachers' instructional strategies (guided inquiry, cooperative learning and direct instruction) and three learning styles (visual, auditory and kinaesthetic) and their influence on students acquisition of process skills in Physics practical. The target population was all form three Physics students in Navakholo Sub-County area of Kakamega County. A sample size of five hundred and nineteen (519) form three physics students were selected through multistage sampling procedures (purposive sampling, proportionate stratified random sampling and simple random sampling). One null hypothesis was tested at 0.05 level of significance to guide the study. Physics Process Skills Checklist (PPSC), Learning Style Questionnaire. Teachers' Instructional Guides on Guided-Inquiry (TIGITS), Cooperative (TIGCTS) and Direct Instructional Strategy (TIGDITS) were used to collect data. Validity and reliability of the instruments were assessed. Analysis of covariance (ANCOVA), Multiple Classification Analysis (MCA) and Scheffe multiple comparison test were used to analyse the data. Findings revealed, a significant effect on the acquisition science process skills of physics students taught with different instructional strategies considering their different learning styles.

Keywords: *Instructional practices, Learning styles, Process skills acquisition, Physics practicals*

Introduction

In the present era of science and technology, the knowledge of scientific innovation has grown tremendously. Equally, technology has also progressed at a rapid pace. The effects can be seen in all aspects of our lives. Science education plays a significant role in the future of societies. As science and technology become increasingly complex, nations have continued to seek for improvement in the quality of science education, particularly in developing countries like Kenya. The quality of science education could be attributed to factors such as; innovations in teachers' instructional strategies like (Direct instruction, Guided-Inquiry, and Cooperative learning) in science, identification of students' learning styles in science class before teaching, availability of learning resources among others. In the 21st century, great emphasis is placed on science education because science and technology are considered as the essential tools for the growth and development of any nation (Njoroge, Changeiywo & Ndirangu, 2014).

Instructional strategies are important path-ways for science teachers and should be applied appropriately to enhance the learning outcomes of students. Teaching is an "art," but the success of a teacher lies in making his subject so simple as to make it intelligible for his students (Ntibi & Neji, 2018). According to Archibong (2009), the interest which students show in science subjects and physics included, the mastery they demonstrate on completion of a course of study depend on the instructional strategies and materials. In spite of much focus on teaching strategies in physics, students' performance in the subject has continued to record a persistent variable trend in Kenya (Akweya etal, 2015).

Learning styles has no one definition and different terms are used in literature such as learning styles, cognitive styles, sensory preference, and personality types. Various researchers have attempted to provide ways in which students' learning styles influence students' acquisition of science process skills e.g accordings (Gopalakrishnan & Palanivelu , 2017), Learning is defined as modification of behavior through experience. It is also defined as the acquisition of a desirable behavioral pattern. In other words, learning is the modification and coordination of the response of the organisms. However, Mortimore (2003) has made a distinction between learning styles and cognitive styles. He indicates that learning styles are seen more in terms of the strategies that learners use to deal with learning and are considered to be less stable than cognitive styles.

Duran, Işik, Mihladiz & Özdemir (2011) in Turkey, in their study, to determine the relationship between the pre-service science teachers' scientific process skills and their learning styles assert that when science process skills scores are generally examined, it is seen that the pre-service teachers having separate and changing learning styles have higher science process skills scores when compared to the pre-service teachers having the other learning styles. Arı & Bayram, (2011), reported whichever teaching method the student is subjected to, some learning styles are more advantageous over other learning styles in terms of scientific achievement and scientific process skills.

Science process skills are important aspects of practical work in science and specifically in physics. The search for a more active approach for the teaching and learning of science that will enhance the acquisition of process skills has persisted over the years (Guevara, 2015). This is because; the acquisitions of science process skills are the basis for scientific inquiry, development of intellectual skills, motivation and attitudes that are needed to learn scientific concepts. Science process skills are cognitive and psychomotor skills employed in problem-solving. They are the skills which the sciences use in problem-identification, data gathering, inference, interpretation, and communication (Karamustafaoğlu, (2011). Science process skills can be acquired and developed through training such as are involved in science practical activities. They are the aspect of science learning, which is retained after cognitive knowledge has been forgotten. Using science process skills is an important indicator of the transfer of knowledge which is necessary for problem-solving and functional living. The experience of process skills in science is significant for the proper understanding of concepts in science. Alfredo et al. (2006) stated that process skills are fundamental to science, which allows everyone to investigate and reach conclusions. They observed that there is a severe educational gap in this area, both in bringing these skills into the classroom and in the training of teachers to use them effectively.

In a study that investigated the levels of possession of science process skills i.e. observation, experimentation, measurement, communication, and inference by final year Nigerian Certificate in Education (NCE) Students in colleges of Education in South-Eastern States of Nigeria, Omiko & Akani (2015), observed that there were high level possession of observation, experimentation and measurement skills and low level possession of communication and inference skills by the respondents and gender-related significant difference in level of possession of the skills. Based on the findings, it was recommended that teacher-trainers should emphasize more on skills acquisition.

Problem Statement

Science education in Kenya has undergone many reforms. In recent years, a number of studies have investigated the teaching of Science subjects among which Physics is a core science subject. Strengthening Mathematics and Science Education (SMASE) in-service training programme was set up as an intervention measure in 1998 following the low quality of teaching and learning in mathematics and sciences (SMASE, 2003). The mean scores for science, particularly physics, have remained below the expected margin in most secondary schools in the country (Kenya National Examinations Council, 2017). The low performance in science subjects, particularly Physics, may contribute to having a negative impact on upward mobility of many learners in science related subjects. Besides all the intervention offered by the Ministry of Education Science and Technology (MoEST), poor performance is still registered. In view of these, the question then arises "could there be any observable changes in the students' process skills acquisition with different learning styles taught using different instructional strategies?"

Purpose of the Study

The purpose of the study was to investigate the influence of teachers' instructional strategies and students' learning styles on students' process skills acquisition in Kenyan secondary school physics. Specifically, the study was designed to examine the process skills acquisition of physics students with different learning styles (Visual, Auditory and Kinaesthetic) taught using different instructional strategies (guided inquiry, cooperative learning and direct instruction).

Research Design

Quasi-experimental pretest – posttest non-equivalent control group design was adopted for the study. The population of the study consisted of all the 694 form three physics students in the 24 public secondary schools in Navakholo Sub county area of Kakamega County, Kenya. A total of 519 students took part in the study in their intact classes. Multistage sampling technique was used. It involved; purposive sampling, proportionate stratified random sampling and simple random sampling techniques. Purposive sampling was used to select secondary schools with at least one intact stream of physics students at form three and one trained physics teacher out of 24 schools in Navakholo sub-county. A total of twenty-one schools were selected from the 24 schools. After the purposive sampling of schools with at least one intact physics stream, proportionate stratified random sampling was used to select 21schools that were used in the study based on their proportion in each division. Physics Achievement Tests (PAT1), (PAT2) and Learning Styles Questionnaire (LSQ) were the instruments used to gather data for this study. The questionnaire instrument formulated by Barbe, (1979) was used to determine students' individual learning styles. The Questionnaire was a thirty (30)) multiple choice instrument, where a respondent chose from options (a), (b) and (c) which represent preferred learning style (Visual, auditory and Kinaesthetic respectively). The PAT1 20 items testing three practical skills questions. It was administered to students as a pre-test and post-test. The PAT1 was designed to assess students' achievement in the selected physics topics. The time allowed for the test was 2 hours. A marking scheme was prepared and used to score the test. Each tested skill was allocated ten marks giving a maximum possible score of 30 marks and a minimum possible score of 0.The validation of LSQ was ascertained by three psychologists while that of PAT1 and PAT2 was ascertained by three physics educators. The instruments were pilot-tested with 75 students in two schools that was not used for the main study. Test-retest approach was used to establish the reliability of LSQ and the results obtained were subjected to Pearson Product Moment Correlation. The result showed that LSQ has a reliability coefficient of 0.84. The results obtained from PAT1

were also subjected to test-retest approach and the result showed a reliability coefficient of 0.81.

Teacher quality variables were controlled by using research assistants who were the physics teachers in each school to teach each group. Training on the use of the instructional strategies was conducted for the research assistants in the one week preceding the study. A pre-test was administered to both the experimental and control groups and the results were used as covariate measures in order to take care of possible initial differences in groups. After the pretest, the subjects were taught the concept of current electricity for four weeks. The experimental group 1 was taught using guided inquiry, experimental group 2 was taught using cooperative learning while the control group was taught using the direct instructional strategy. A post-test was administered to all the groups at the end of the treatment period. LSQ was also administered to the students and the results were used to classify the students into their respective learning styles. The data collected were analyzed using descriptive statistics, analysis of covariance ANCOVA, multiple classification analysis MCA and Scheffe's post hoc test. The hypothesis was tested at .05 level of significance.

Results

Table 1: Descriptive Statistics of Pre-test and post-test and the mean gain scores

		Process Skills Acquisition Tests				
Teachers' Instructional Strategies	**Student's Learning Styles**	**Pre-test**		**Post-test**		**Number of students**
		Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	
Direct Instruction	Visual	39.93	15.59	62.75	13.85	83
	Auditory	37.94	12.24	57.00	13.43	59
	Kinaesthetic	37.76	10.71	66.00	14.10	55
	Average	38.82	13.49	62.50	14.14	177
Cooperative learning	Visual	36.94	11.15	60.71	13.19	73
	Auditory	37.77	12.55	65.84	15.47	59
	Kinaesthetic	38.22	12.16	72.79	14.89	54
	Average	37.58	11.98	65.84	15.19	186
Guided-Inquiry	Visual	35.71	11.24	62.31	15.31	59
	Auditory	35.16	10.54	58.14	13.15	37
	Kinaesthetic	36.08	11.80	74.33	12.71	60
	Average	35.72	11.24	65.94	15.37	156
Average	Visual	37.76	13.14	61.93	14.01	215
	Auditory	37.11	11.91	61.17	14.78	135
	Kinaesthetic	37.31	11.69	71.13	14.27	169
	Average	37.45	12.35	64.73	14.95	519

Table 1 shows the means and standard deviation of the students' process skills acquisition in the pre-test (PAT1) before treatment and post-test (PAT 2) results after treatment. The results of the pre-test show the mean scores and standard deviations of students' learning styles and the teachers' instructional strategies respectively. These mean scores are homogeneous and it showed that before treatment all learners of different learning styles were at the same level.

The results of the post-test also show the mean scores and standard deviations of students' learning styles and the teachers' instructional strategies. The results indicated that the Kinaesthetic learners posted a highest total mean score in the process skills acquisition of (M=71.13, SD=14.27) compared to the Auditory and visual learners who scored (M=61.17, SD=14.78) and (M=61.93, SD=14.01) respectively. The table also shows that on average, students instructed by Guided-Inquiry had the highest mean score of(M=65.94, SD=15.37) compared to Cooperative learning strategy of mean score(M=65.84,SD=15.19) and direct instruction strategy of mean score(M=62.50, SD=14.14). These results show that after treatment there was a significant difference in the mean scores of the students' process skills acquisition based on the instructional strategies for the students with different learning styles.

The results show that the students of Kinaesthetic learning style had a higher process skills acquisition (M=71.13, SD=14.27) compared to those of visual and Auditory learning styles. On the other hand, students instructed by guided inquiry (M=65.94, SD=15.37) had a higher rate of skills acquisition than cooperative and direct instructional strategies.

Hypothesis One
There is no significant difference in the achievement of physics students with different learning styles when taught using different instructional strategy while controlling for gender. To test this hypothesis, ANCOVA was computed and the results are presented in Table 2.

Table 2: Results of Analysis of Covariance (ANCOVA) with Process Skills as DV and Instructional Strategies as IV and Gender as Covariate

Dependent Variable: Process Skills Post-Test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	16908.381[a]	17	994.611	5.037	.000	.146
Intercept	216776.504	1	216776.504	1097.831	.000	.687
Main Effect						
Instructstr	304.844	2	152.422	.772	.463	.003
Learnst	3860.487	2	1930.243	9.775	.000	.038
Gender	305.468	1	305.468	1.547	.214	.003
2-way Interactions						
Instructstr * Gender	26.670	2	13.335	.068	.935	.000
Learnst * Gender	946.957	2	473.479	2.398	.092	.009
Instructstr * Learnst	889.585	4	222.396	1.126	.343	.009
3-way Interactions						
Instructstr * Learnst * Gender	474.828	4	118.707	.601	.662	.005
Error	98926.926	501	197.459			
Total	2290707.000	519				
Corrected Total	115835.306	518				

a. R Squared = .146 (Adjusted R Squared = .117)

Table 2 shows the result of the ANCOVA at α=0.5 level of significance after treatment.The results revealed no significant interaction effect in the three way interaction between the learning styles, instructional strategies and gender for both experimental and control groups ($F_{(4,501)=}$.601, P=.66).All the two way interactions between the teachers' instructional strategies and gender ($F_{(4,501)=}$.601, p=.94),. Students' learning style and gender ($F_{(4,501)=}$.601, p=.092) and teachers' instructional strategies and learning styles ($F_{(4,501)=}$.601, p=.34)were not statistically significant. The predicted main effects of learning styles ($F_{(4,501)=}$.601, p=.000)was statistically significant while that of instructional strategies and gender were not. This results therefore implied that the students' acquisition of process skills was highly influenced by the students learning styles. From the obtained results, the decision was to reject the null hypothesis ($H0_2$) which stated that there was no significant difference in acquisition of science process skills among students with different leaning styles taught using different instructional strategies while controlling for gender. These results mean that the students' learning styles differ significantly in their enhancement of the process skills acquisition in physics practical work. On the other hand, the results also indicated that the teachers instructional strategies did not have a statistically significant influence on the students' process skills acquisition in physics practical work.

From the findings, it was concluded that students learning styles significantly influenced students acquisition of process skills ($F_{(4,501)=}$.601, p=.000) after treatment. Following the existence of significant difference in the process skills acquisition by students of different learning styles instructed by different strategies, a Multiple Classification Analysis (MCA) was conducted to determine the influence of the independent variables (learning styles and instructional strategies) as shown in Table 3.

Table 3: Multiple Classification Analysis (MCA) of the post-test Process Skills Acquisition Scores

Grand mean=63.4644							
Variable and Covariates			**N**	**Unadjusted Devn′**	**Eta**	**Adjusted for independent +Covariate**	**Beta**
Process Skills Post-Test	Student's Learning Styles	Visual	215	-1.12017	.132	-.97529	.131
		Auditory	135	-1.63472		-1.79038	
		Kinaesthetic	169	2.73091		2.67094	
	Teachers' Instructional Strategies	Direct Instruction	177	-2.12537	.107	-2.10349	.105
		Cooperative learning	186	.81522		.99047	
		Guided-Inquiry	156	1.43949		1.20571	
Multiple R^2			.169				
Multiple R			.028				

Table 3 shows results of Multiple Classification Analysis (MCA)of process skills acquisition of students of different learning styles used to determine the magnitude of practical skills acquisition means scores. The results show that learning styles (Visual, Auditory and Kinaesthetic) have an index relationship of 0.132 (Beta value of 0.131) with the process skills acquisition in physics practical work. The results also indicate that the deviation from the grand mean of 63.46 of the adjusted pos-test scores of students of visual learning style is-0.97, while the deviation of the adjusted post-test scores of students of Auditory learning style is -1.79and the adjusted pos-test scores of students Kinaesthetic learning style is 2.67. The multiple regression index R of 0.028 and multiple regression squared index (R^2) of 0.169, imply that 16.9% of the variance in the students' process skills acquisition was attributable to the influence of the students' learning styles (Visual, Auditory and Kinaesthetic).

Results of the Multiple Classification Analysis (MCA), as presented in Table 4.8, were also used to determine the magnitude of the process skills acquisition mean scores of students exposed tothe different treatment conditions. The results showed that instructional strategies (Guided-Inquiry, Cooperative learning and Direct instruction) had an index relationship of 0.107 (Beta value of 0.105) with the process skills acquisition in physics practical work. Table 4.5 also indicates that the deviation from the grand mean of 63.46 of the adjusted pos-test scores of students taught using the Guided-inquiry instructional strategy is 1.21 while the deviation of the adjusted post-test scores of students taught using Cooperative learning instructional strategy is 0.81 and the adjusted pos-test scores of students taught using Direct instruction strategy is -4.93. The multiple regression index R of 0.028 and multiple regression squared index (R^2) of 0.17, imply that 17.0% of the variance in the students' process skills acquisition was attributable to the influence of instructional strategies (Guided-Inquiry, Cooperative learning and Direct instructional strategies).

Based on the finding of the multiple classification analysis MCA, it was concluded that both independent variables (learning styles and instructional strategies) had an influence on students' acquisition of process skills at the level of learning styles (R^2=.17, β=.13) and instructional strategies (R^2=.17, β=.11) respectively. Therefore, learning styles had a more positive influence.
Following the existence of significant difference in the process skills acquisition by students of different learning styles instructed by different strategies, a Scheffe's post hoc test for multiple comparison was conducted to determine where the difference occurred in the process skills acquisition as shown in Table 4

Table 4: Result of Scheffe's Post Hoc Test for Multiple Comparison of Learning Styleson Students'Process Skills Acquisition in Physics Practicals

(I) Student's Learning Styles	(J) Student's Learning Styles	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Visual	Auditory	.5146	1.55226	.947	-3.2962	4.3253
	Kinaesthetic	-3.8511*	1.45318	.031	-7.4186	-.2836
Auditory	Visual	-.5146	1.55226	.947	-4.3253	3.2962
	Kinaesthetic	-4.3656*	1.63171	.029	-8.3714	-.3599
Kinaesthetic	Visual	3.8511*	1.45318	.031	.2836	7.4186
	Auditory	4.3656*	1.63171	.029	.3599	8.3714

Based on observed means.

The error term is Mean square (Error)= 199.817.

Table 4 shows that the mean difference between Auditory and Visual was 1.49, between Auditory and Kinaesthetic was 2.77 and between Kinaesthetic and Visual was 4.26. This implies that Kinaesthetic learners achieved more in physics practicals considering the teachers' Instructional strategies. The results also indicate that there was a significant difference between students of Kinaesthetic and Visual learning styles, then Kinaesthetic and Auditory learners. This means that all the possible pairs therefore contributed to the significant effect obtained on students' acquisition of process skills considering their instruction strategies.

Discussion of Findings

The results in Table 2 indicated that a significant difference was found to exist in the acquisition of process skills by students of different learning style (Kinaesthetic, Auditory and Visual) in physics practicals work after being exposed to different instructional strategies (Guide-inquiry, Cooperative learning and Direct instruction). As a result, the hypothesis which stated that there is no significant difference in acquisition of physics process skills among students with different leaning styles taught using different instructional strategies was rejected. Multiple Classification Analysis (MCA) as shown in Table 3 indicated that 63.46 % of the total variance in the acquisition of process skills by students in physics practices work was attributed to the influence of students' learning styles after being exposed the respective instructional strategies. The Scheffe's post hoc analysis as shown in Table 4 indicated that there was a significant difference between students of Kinaesthetic and Visual learning styles, then Kinaesthetic and Auditory learners. This means that all the possible pairs therefore contributed to the significant effect obtained on students' acquisition of process skills considering their instruction strategies. The Scheffe's post hoc analysis as shown in Table 4 indicated that there was no significant difference in the influence of the students acquisition of process skills by the respective instructional strategies (guided-inquiry, Direct instruction and Cooperative learning).

These results also agree with those of Athuman (2018) in the study on Comparing the effectiveness of an inquiry-based approach to that of conventional style of teaching in the development of students' science process skills. The results revealed that the experimental group students performed better in science process skills after undergoing treatments of inquiry constructivist activities as compared to their counterparts in the control group. An analysis of independent samples t-test based on type of instruction students received at (α) =0.05 produced a p of 0.047 and a t value of 0.633. However repeated measures ANOVA found that regardless of the method of teaching, there were significant within-groups effects with regard to the development of science process skills. The findings also agree with those of Aydoğdu (2015) in terms of gender who found a significant difference between basic and integrated skill scores and overall SPSTFT scores of elementary school teachers with regard to their gender. It was detected that these significant differences were in favor of female teachers. In the study it was reported that the science process skill levels of elementary school teachers did not differ significantly in terms of gender.

Conclusion

The results of descriptive statistics showed that the teachers instructional strategies attained mean scores (Guided-Inquiry achieved (M=65.96, SD=17.92), Direct Instruction (M=56.67, SD=15.90) and Cooperative learning (M=62.65, SD=17.40) against the maximum of M=100% on students' academic achievement. The ANCOVA statistics revealed a significant interaction between instructional strategies and gender (F(4,501)=1.13, p=.000) at α=.05. These results implied that there was significant influence of teachers' instructional strategies on students' academic achievement in physics practical work. The results of the multiple classification analysis test revealed that both independent variables

(learning styles and instructional strategies) had an influence on students' academic achievement at the level of learning styles(R^2=.24, β=.091) and instructional strategies(R^2=.24, β=.21) respectively. The Scheffe's Post-Hoc test revealed the direction of the difference in the students' achievement in physics practical work was due to Direct Instruction strategy. Results of intervening effect of gender on teachers instruction strategies and students learning styles it showed that girls performed better than boys in the physics practical work as reflected by the academic achievement mean scores of (M=65.41, SD=17.33) and (M=60.31, SD=17.32) respectively. Therefore, based on the results of this study it was concluded that teachers' instructional strategies influence students' academic achievement among physics students in practical work in Navakholo sub-county.

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School Environmental Factors and their Impact on Competency-Based learning outcomes in Mains Electricity in Public Secondary Schools, Bungoma County-Kenya

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Abstract

Quality education is vital tool for any community and country as a whole as it enables people to develop all their attributes and skills to achieve their potential. It is to this regard that the government of Kenya through the Ministry of Education is working tirelessly to improve quality of education through reforms. Since 2017, there have been changes in the system of education from 8.4.4. to 3.6.3.3 which is the Competency-Based Curriculum. Most of reforms in Kenyan education system since independence has never been implemented fully hence not meeting their initial set objectives. Secondly, most countries in Africa, Competency-Based Learning has failed at implementation stage because of the school environmental factors. Science has been emphasized a lot in in Competency-Based learning in most of pathways, as a result of this, this study took into consideration Physics. Physics is considered to be a vital subject because it inculcates critical thinking and problem-solving skills which are some of the core Competencies in Competency-Based Learning. A Well-coordinated and organized learning environment could result to quality implementation of Competencies in Competency-Based learning which inculcates the required competencies in mains electricity for application of learned knowledge in the community. The school environmental factors are not well-coordinated in Kenya that enhances CBL which may compromise quality of learning outcome. The research was concerned with how best to coordinate school environmental factors with scarce resources and the effect of school environmental factors on quality implementation of Competency-Based Learning in form Three to enhance community learning service. The study was carried out as a desktop study, where by information was collected from internet, public libraries and Education institutions. The results indicated that, students taught in a well-organized classroom had necessary skills and positive attitude towards given task and were able to provide quality community learning service. The results further indicated that teachers who were well trained and were provided inadequate resources were not able to effectively implement CBL. When teachers are trained with basics of Competencies in Competency-Based Learning and given virtual platform to share and discuss issues affecting teaching and learning process, they improve their competencies. Teachers ought to be well trained in Competencies in Competency-Based Learning, encouraged to form subject forums and be provided with adequate learning and teaching resources for quality implementation of CBL. This study will help in the smooth roll out of Competency-Based learning in secondary school level by providing the roadmap for quality implementation of Competency-Based learning, it will also help in teacher professional development in colleges and universities and curriculum reforms in the Country.

Keywords: *Competency-Based Learning, STEM, Problem-Solving Skills*

Introduction

Quality education is a vital tool in development of any community and County as a whole. It plays a key role in human, social and economic development (Sheykhjan,T.M, 2015). Education is a vital human right, enshrined in the universal declaration of human right of the child (Global partnership for Education, 2019). Thus, Nelson Mandela stated that, “education is the most powerful weapon which you can use to change the world”. According to Nelson, J. (2015) an educated person leads to innovation, high level of productivity and increased economic growth. Basing on this, the Kenyan government is keen on constantly improving quality of education system since independence.

The Ominde commission of 1964 proposed education system that supported national unity while nurturing the desire of the students to serve the newly formed nation, (Simiyu, 2011). The system was criticized for being too academic, lacked flexibility and capacity to address changing labor market needs in terms of new skills, new technologies and attitude to work. The system had high enrolment with scarce resources which compromised the quality of education thus many school leavers were unemployed. It also lacked relevant and appropriate content to ensure widespread and self-employment, (Omondi. G, 2018, Wanjohi M.A, 2011 and Simiyu, 2001).

The Gachati report G.O.K, 1976 raised the issue of unemployment in relation to 7.4.2.3 system which resulted to increased school dropouts from swelling education system. The report recommended restructuring of the education system so as to emphasize on Mathematics, Technical and Vocational subjects (republic of Kenya, 1976). Mackey report of 1981 proposed 8.4.4. system of Education from 7.4.2.3. system of Education with the aim of equipping learners with skills that would enable school dropouts to secure self-employment and this was to be necessitated by introduction of vocational and technical subjects in primary. The system emphasized on Sciences, Mathematics, Technical and Vocational subjects to nurture technical skills necessary for revamping innovation for sustainable development. The Kamunge Report 1988 noted the challenge of financing, quality and relevance of education system that was as a result of inadequacy of instructional materials which compromised with quality of education. Through sessional paper number 6, recommended cost sharing and in-service of teachers to equip teachers with the necessary skills that will facilitate

smooth transition. In addition, king and McGrath (2002) argue that 8.4.4. resulted from assumption that the system could equip the learners with skills necessary for job market thus dropouts at all levels could either be employed or self-employed.

According to Omondi (2018), the system faced the following challenges, lack of adequate government funding, inadequate human capacity to develop the new 8.4.4. curriculum, trial and error implementation process, the system received no good will from teachers who were tasked with implementation process. As a result of the above challenges, the system was too broad, expensive and burdensome to pupils, parents and teachers. It also failed to achieve its initial objective stated in Mackey report; the number of dropouts increased. The trainees of the system failed to acquire skills necessary to pursue entrepreneurship and attain self-reliance. (Wanyama P.M and Chang'ech, J.K, 2013)

According to Wanyama, (2013), due to many challenges the 8.4.4. system of education was facing since its onset, Kenyans yearned for education reforms that would propel it towards achievement of vision 2030. Wanyama recommended that there was need to take time or plan for gradual change than taking a short time to think and implement the change in education, need for education and training for teachers to change/reform because there were teachers who were not well equipped with teacher competencies. Zeleza, P. (2017) argues that the new system reform plan should have represented an effort to move away from a theory and test-based system to skill-based system. Furthermore, the vision of the curriculum reform was to nurture every learners' potential and address key issues such as ethical values, equity and equality of opportunities.

Following the above-mentioned criticism and challenges facing 8.4.4 system of education, and the Ministry of Education, (2012) report from task recommended that content for basic education was to be designed with a view of equipping learners with relevant knowledge that emphasizes on technology, innovation and entrepreneurship. Later in 2015, sessional paper No. 2 recommended the establishment of competency-based curriculum. The government through ministry of education had to reform its education system from 8.4.4 to 2.6.3.3-Competency-based curriculum. According to Nyakang'i, E. (2019), Competency-Based Curriculum (CBC) is a new system of Education designed by the Kenya Institute of Curriculum Development (KICD) team and launched by the Ministry of Education in 2017. The CBC is designed to emphasize the significance of developing skills and knowledge and also apply those competencies to real life situations. The CBC utilizes Competency-Based Learning which according to Gervais (2016) is learner focused and learners works more independently while the teachers acts as facilitators. Learners often find different individual skills more difficult than others. This learning method allows a student to learn those individual skills they find challenging at their own pace, practicing and refining as much as they like.

In Sessional paper No. 1 of 2019, objectives of education of all levels in CBC are stated which has to be achieved, secondary level of education objectives include: (i) Develop necessary knowledge, skills and attitudes for the development of self and the nation. (ii) Promote love for and loyalty to the nation. (iii) Promote harmonious co-existence among the peoples of Kenya. (iv) Develop mentally, socially, morally, physically and spiritually individual (v) Enhance understanding and respect for own and other people's cultures and their place in contemporary society (vi) Prepare students for global citizenship (vii) Enhance understanding and appreciation of inter-relationships among nations. (viii) Promote positive environmental and health practices. (ix) Build a firm foundation for further education and training. (x) Develop ability for enquiry, critical thinking and rational judgment. (xi) Develop into a responsible and socially well-adjusted person. (xii) Promote acceptance of and respect for all persons. (xiii) Enhance enjoyment in learning. (xiv) Identify individual talents and develop them. (xv) Build a foundation for technological and industrial development. (xvi) Develop into self-disciplined individual who appreciates work and manages time properly. Competency based learning would be able to meet these objectives because of it benefits. (Gruber, G. 2018)

The government was keen on common challenges that had always faced education reforms in Kenya since independence that could hinder achievement of the above-mentioned objectives. Such challenges include: negative criticism due to lack of consultation of key stakeholders, unpreparedness of teachers to handle new curriculum hence resistance, partial implementation of recommendations, inadequate funding by government and political interference. To overcome these challenges, the ministry has taken a number of steps including formation of task force by the Ministry of Education to undertake a broad stakeholder's engagement and identify international best practices, (Daily Nation, June 21st, 2019). Munyao, B. (2019) asserts that the Ministry of Education pledges to uphold continuous consultation with stake holders. The Daily Nation (June 21st, 2019) reported that National assembly approved sh. 2.4 billion to cater for CBC rollout.

The researcher of this study was concerned with immediate school environmental factors that were likely to affect negatively implementation process of Competency-Based Learning at secondary school level in Physics. This was with aim of smooth transition of system of Education from knowledge based to Competency-Based Education in secondary schools so that learners could acquire the seven core competencies of CBC. Successful implementation of CBC is mainly dependent on cooperation between all stakeholders and how all school environmental factors that have earlier affected education reforms negatively will be handled (Chaudhary, G. K., 2015)

According to Mustapha, et al. (2014) school environmental factors are categorized into, teacher factors, learning resources, learning work load, learner factors and leaning community. Asfani, K.S. Swanto, H. and Wibaw, A.P. (2016) categorizes influential factors of students' competencies as student factor, teacher factors, supporting factors and parental factors. The researcher will take into consideration of school environmental factors from the two categories including; teacher factors, learning-teaching resources, learning communities and learner competencies.

This study has taken into consideration physics because in all reforms since independence sciences and technology has been emphasized as key to realization of vision 2030. Furthermore, in the new curriculum physics in senior secondary Education has been taken into consideration in almost all STEM pathway options, (Wanjohi A.M., 2017). This is purely because of its value to students. Sultan, S.B.B. Aziz, I.A. and Charles S.S. (2019) indicates that, 'Studying physics can be as fundamental as the conversion of electrical energy to heat to make the morning coffee or as complex as plotting a space shuttle flight from Earth into orbit. Even though some concepts are initially difficult to grasp, the reward regarding satisfaction and knowledge can make all the effort worth it'.

Sultan further gives importance of studying physics as; development of logical thinking and ability of thinking intellectually, improving the quality of lifestyle by providing new instruments and techniques in every field and problem-solving skills, the skills are applicable to Many fields, crucial in intellectual development as well as being a wide field of carrier development.

According to The Glossary of Education Reforms, (2014), the general goal of competency-based learning is to ensure that students acquire knowledge, skills and attitude that are deemed to be essential to success in school, careers, and adult life. This is evident on the process of learner providing Community learning service. The quality of Community learning service depends on the quality of teachers, the range and effectiveness of teaching, learning and the quality of the infrastructure at school level, (Stabback P.,2016). In most of the African Countries, competency-Based learning has faced a number of challenges including inadequate resources, teachers lack capacity to implement CBC (Makunja G.,2015 and Komba S.C, and Mwandanji M., 2015). Study done by Sifuna, D.N. and Obonyo, M.M. (2019) on CBC in primary schools in Kenya shows that the system already has had challenges including ineffective training of teachers due to overloaded content, incompetent facilitators who had not conceptualized and understood CBC hence were unable to adequately facilitate envisioned training. The head teachers were not trained on how to assess learning, teachers and teaching process of the learning areas as well as core competencies. Preparation of schemes and lesson plan is lengthy and entails a lot of paper works hence time consuming thus limited time left for teaching. Sifuna further points out inadequate supply of teaching and learning resources. This study is concerned with school environmental factors which are likely to impact negatively implementation of Competency-Based learning with aim of smooth transition from knowledge-based learning to Competency-Based learning.

Purpose of the study

The main purpose of this study was to find out the effect of school environmental factors on community Learning Service in Competency-based Learning in mains electricity on public secondary school students with aim of smooth transition from Primary to Junior Secondary in 2023.

Statement of the Problem

According to Wanjohi, A. (2018), physics is one of science subjects considered in Competency based curriculum to be vital, most options in senior secondary STEM has factored in physics. Physics has been found to inculcate critical thinking and problem-solving skills to secondary school students, (Sultan, S. et al, 2019). The learning environment could reflect the quality of teaching and learning process, (Mustapha, R. Rahman, S. Muktar S.B. and Husain, M.Y., 2014). Environmental factors are influential to learning outcomes in that facilities and infrastructure at school determines the quality of teaching and learning process hence improvement of leaning outcomes, (Earthman, G.I., 2002 and Tschanan-Moran, M., 2008). Teacher competencies strongly affect learner competencies that have positive effect on students' intrinsic motivation and learning outcomes and attitude towards learning.

It was evident that 8.4.4. system of education in Kenya failed to produce all round individual with right competencies and values who could compete globally and be less dependent on white collar jobs, (Wanjohi, A. M. 2012). Despite the fact that the system objective was to deal with prevailing problems of unemployment and incompetence in field of specialization, these were not achieved because of poor implementation process. According to Wanjohi A.M., (2018) Competency-Based Curriculum is already facing challenges at lower primary including inadequate resources and teachers lack capacity demanded by curriculum implementation. From the studies it is clear that what led to this include; low teacher competencies', traditional methods of teaching, inadequate teaching and learning resources, partial implementation of recommendation and resistance from stake holders, (Wanyama, 2013).

The government of Kenya was on the process of reforming its system of education from 8.4.4. to 2.6.3.3. to alleviate these problems associated with 8.4.4. The new system will be rolled out in junior secondary school in the year 2023

in Grade 7. The new system, CBC emphasizes on the learning outcomes as opposed to current system of education. What will determine the successful implementation of the new system is how the government will put in place all factors that are likely to affect the implementation process. The researcher was concerned with the school environmental factor including; teacher competencies', classroom environmental factors, teaching and learning resources and ICT infrastructure. This was with aim of making sure that schools and teachers are well prepared to support the new system to improve on learner acquisition of core competencies, improve performance in physics and application of acquired skills in developing the community and well-being of the individual.

Methodology

The research adopted desktop study research technique where External desk research was adopted. The study targets at form three learners in public secondary schools in Bungoma County. The secondary data was collected from government published reports and published journals, public libraries, Education institutions and published books. The literature was scanned from secondary data then analyzed through secondary analysis where content analysis approach was utilized and finally the reference was created from reviewed secondary sources.

Findings

The purpose of the study was to ascertain the effect of school environmental factors on competency-based learning outcomes on mains electricity in form three. This was with aim of advising relevant stakeholders on how best to prepare for smooth rollout of Competency-Based curriculum in 2023 in Junior Secondary. The study found that Competency-based programs have the potential to increase the alignment between graduate skills and employer needs,

The study ascertained that when teachers are well in serviced, they are able to implement Competency-Based curriculum and developed competency-based skills. The study indicates that when CBC is effectively implemented students feel motivated and enjoy teaching and learning environment hence they are able to provide quality Community learning service with ease.

The study further indicates that learners were not able to provide quality Community learning service because teachers were not able to implement CBC effectively due to lack of teaching and learning materials though they had undergone in service training and they had also opportunity to form Community professional learning groups to discuss challenges they were facing.

The study shows that teachers who were given opportunity to form Community professional learning groups had positive attitude towards implementation of CBC regardless of prevailing challenges, teachers further appreciated work done by curriculum support officers in monitoring and evaluation though wished that the session could be used as platform to express their challenges. Learners taught by this group of teachers were able to offer quality Community learning service because they had acquired all the core competencies.

The study further noted the following challenges; classes that were crowded posed a challenge to active teaching and learning process, It also found that the mindset of teachers was another hindrance to effective teaching and learning of Physics as some teachers did not belief in new system and instead continued using old system methodologies.

Discussion

The results indicate that, students taught in a well-organized classroom had necessary skills and developed positive attitude towards given task and were able to provide quality community learning service. This is in line to study done by Mosha, (2012), who argued that only few teachers who benefited from Support to Education in Primary Schools (STEPS) by Aga Khan Foundation (AFK) were able to prepare for competency-based curriculum and developed competency-based skills.

The results further indicate that teachers who were well trained and were provided inadequate resources were not able to effectively implement CBL. This is in agreement with report by Uranana Rwabaresi Magazine, (July 6th, 2018) which noted that teacher ought to be provided with quality and adequate resources for effective implementation of CBL. Muneja (2015) further noted that, huge classes, insufficient teaching and learning resources, inadequate teaching staff in science subjects and low quality of textbooks as some of the challenges facing CBC.

When teachers are trained with basics CBC and given opportunity to network through virtual platform (professional learning communities-PLC) to share and discuss issues affecting teaching and learning process, they tend to improve their teaching competencies. These findings agree with Muneja (2015) who argued that teachers ought to coordinate among themselves for continuous improvement of implementation process of CBC.

Conclusion

From the research findings it is evident that most of countries in Africa, CBL has not been effectively implemented due to school environmental factors including inadequate in-service training of teachers, inadequate resources and lack of coordination among teachers to enhance their ability to implement CBL effectively. This in turn results to leaners not acquiring the expected core-competencies thus hindering them form acquiring required attitude, skills and competencies to offer quality community learning service. It is therefore important that teacher in-service training be elongated to enable teachers acquire skills that will enable them implement CBL effectively; teachers also should be given room to form virtual forum Professional Learning Community to help them discuss challenges they face on the process of curriculum implementation. Adequate teaching and learning resources should be provided for quality implementation of CBL. Institutions should invest time and resources to ensure quality implementation of Competency-Based Curriculum programs.

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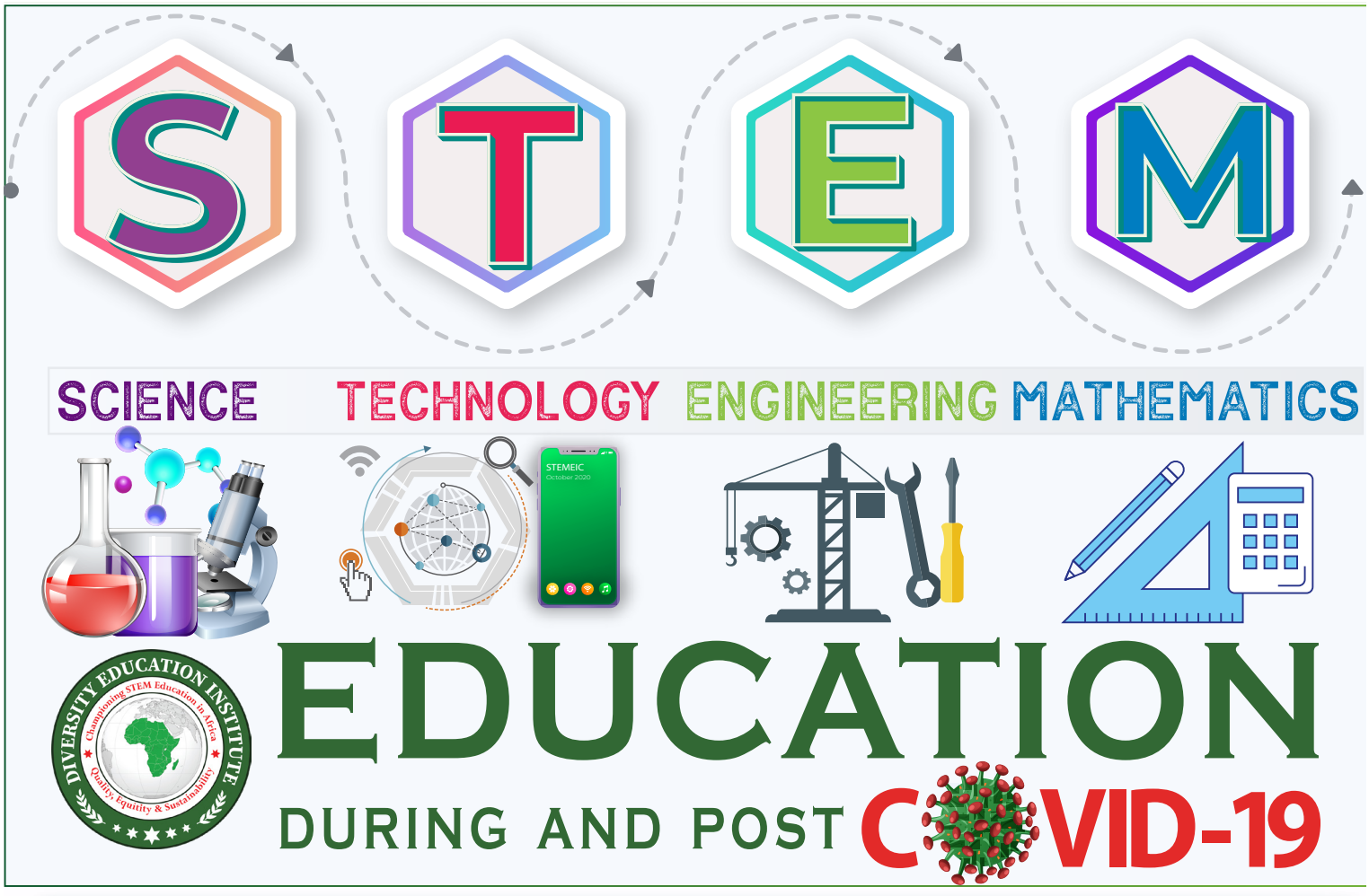

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