

UNIVERSITY OF EDUCATION, WINNEBA

**THE IMPACT OF COVID-19 ON THE TEACHING OF BIOLOGY IN
SENIOR HIGH SCHOOLS**

FRANK BLESSED AMENYEKE



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DECLARATION

STUDENT'S DECLARATION

I, Frank Blessed Amenyeke, hereby declare that this thesis with the exception of references contained in published works which have been identified and acknowledged, is entirely my own original work, and that it has neither in part nor whole been submitted for another degree elsewhere.

SIGNATURE:

DATE:

SUPERVISOR'S DECLARATION

I hereby certify that the preparation and presentation of this thesis was supervised in accordance with the guidelines on supervision of thesis laid down by the research and graduate school, University of Education, Winneba.

NAME OF SUPERVISOR: DR YEBOAH KWAKU OPOKU

SIGNATURE:

DATE:

DEDICATION

This thesis is dedicated to the almighty God and His believed son Jesus Christ, the author and the finisher of my faith and my dear sons Kevin Nana Owusu-Mintah and Kwaku Adentwi Owusu-Mintah.



ACKNOWLEDGEMENT

To my wonderful project supervisor Dr Yeboah Kwaku Opoku, I say a big thank you for all your effort, guidance and steadfastness toward the success of this thesis. May God in His infinity mercy perfect that which concern you and your family in Jesus mighty name, Amen.

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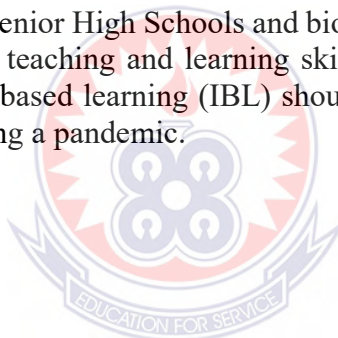


LIST OF ABBREVIATIONS AND ACRONYMS

ACT	Association for Constructivist Teaching
E learning	Electronic Learning
IBL	Inquiry-Based Learning
ICT	Information and Communication Technology
IT	Information Technology
PBL	Project-Based Learning
POE	Predict-Observe Explain
RBL	Research-Based Learning
SCIS	Science Curriculum Improvement Study
TV	Television
UNESCO	United Nation Educational Scientific and Cultural Organization
UNICEF	United Nation International Children's Emergency Fund
VCR	Video Cassette Recorder
WHO	World Health Organization
WWW	World Wide Web

ABSTRACT

The COVID-19 pandemic which first appeared in China disrupted the normal daily lives of people in the world. Countries including Ghana took various measures to control the spread of the COVID-19 virus which included social distancing, lockdown in the whole country and all schools were closed down which disrupted the whole education system. The study investigated the impact of COVID-19 on the teaching of biology in Senior High Schools in the Cape Coast Metropolis of Ghana. The study also examined the teaching strategies adopted during a pandemic and how these teaching strategies could be employed effectively during a pandemic. One hundred biology teachers were randomly selected with the aid of computer generated numbers for the study. A structured questionnaire was used for data collection. The data collected was prepared and coded using Statistical Package for Social Science software and analyzed using descriptive statistics such as frequency, mean, mode and percentage. The outcome of the study showed that COVID-19 had impacted biology teaching methods in Senior High Schools as schools migrated to remote teaching and learning during the pandemic. However, the study showed that only few of the Senior High Schools in the study area offered remote teaching and learning during the COVID-19 pandemic and this was attributed to lack of educational technologies and poor internet connectivity. The study suggests that school curriculum should be reviewed to adapt to distance teaching and learning in Senior High Schools and biology teachers should be trained to be equipped with remote teaching and learning skills. Again, project-based learning (PBL) as well as inquiry-based learning (IBL) should be adopted to teach biology in Senior High Schools during a pandemic.



CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents background of the study, problem of the study, the purpose of the study, the objectives of the study, research questions, the significance of the study, limitation of the study and delimitation of the study.

1.1 Background to the Study

Covid-19 first appeared in Wuhan, China and was declared as pandemic by WHO officially on March 12, 2020 (WHO, 2020). Covid-19 is a severe acute respiratory disease which spreads very quickly through physical contact especially through the nose, mouth and eyes, and develops in the lungs. The signs and symptoms of Covid-19 are increased body temperature, fever, numbness, cough, pain in the throat, headache, difficulty breathing if the virus has reached the lungs (Syafrida, 2020). The Covid-19 pandemic affected educational systems worldwide as most countries temporarily closed down their educational institutions in an attempt to contain the spread of the virus. These nationwide closures impacted over 60% of the world's student population (Hofer, Nistor, & Scheibenzuber, 2021). Several other countries have implemented localized closures affecting millions of additional learners (UNESCO, 2020). In Ghana, the education sector changed since cases of Covid-19 infections were detected in the country. They prematurely closed all schools and as a consequence compelled teachers to make a switch to a virtual environment, which requires the integration of technology into teaching instructions (Hodges, Moore, Lockee, Trust, & Bond, 2020). They had to change their approach in order to positively impact both the content elements and the students' perceptions. Biology teachers should be able to utilize technology to deliver biology curriculum, assess learners, direct them to research topics, and to use student-

centered strategies integrated with technology (Ghaviferkr et al., 2012). Mulenga & Marbán (2020) explored how prospective teachers engage in online learning activities during the COVID-19 pandemic. The study proposed a comprehensive and advanced pedagogic design to render lessons through virtual classrooms during and beyond the Covid-19 age. Due to the Covid-19 crisis, researchers and educators around the world are trying to find possible alternatives that can work for students to have a paradigm shift from the face-to-face modes of learning to online education.

In biology education, selected teaching methods should support learning biology, learning to do biological science and learning about biological science (Selvaraj, et al., 2021). Several biological topics require approaches promoting experimental problem-solving and process-based skills. The focus is on science investigation processes and the goal is to reach valuable learning results, and students therefore need crucial science content knowledge as well as autonomous learning (Johnson, N. (2020). Many biology teachers will need to reconsider teacher-centered pedagogies and apply more effective student-centered learning methods (Bonk, 2009). Recently reformers of the teaching of science called for new approaches in which students contribute to the growth of their own biological knowledge as an attempt to shift to student-centered learning in which students could formulate and solve problems about biological systems (Quentin, 2014). In student-centered teaching the teacher acts as a facilitator, creating the learning conditions in which students actively engage in experiments, interpret and explain data and negotiate understandings of the findings with their peers (Arkorful, 2015). For students, learning science is an active and constructive mechanism, involving inquiry and hands-on activities (Ronoh, 2014). Teaching and learning biology supported by information and communication technologies would offer an alternative to the solutions used in the traditional lecture -based approach. Learner-centered approaches to

technology-enabled learning can empower learners and leverage good learning experiences that would not otherwise have been possible (Dumont, Istance, & Benavides, 2010). Kennedy and Archambault (2012) found that many teachers felt the strategies used in their face-to-face classrooms would not make sense in the online environment. Therefore, teachers have to change their approaches to teaching and their beliefs about teaching and learning which means switching from giving knowledge to guiding knowledge, in order to provide students with what they need as they needed it.

Yildirim and Sensoy (2018) studied the impacts of science teaching enriched with technological applications on the science course achievement levels. It was determined that science teaching enriched by technical applications would have meaningful effect on the increase of the science course achievements level of the students and the permanence of this achievement. It also showed a significant rise in the science course achievement scores. Thus, using technology in learning environments logically and strategically with the right teaching methods will ease and enhance science learning (Oktaç, 2013). This approach allows teachers to present the content in various ways, using text and multimedia and offered numerous chances for students to interact with the course content (DiPietro, 2010). The importance placed on relationship building and being able to understand students well enough to provide individualized instruction and a safe course environment means that teachers must be adept with virtual communication technologies. Regarding the current circumstances, Sintema (2020) suggested that teachers have to step up their preparedness in containing the negative effects of this epidemic by bringing in teaching modes and strategies aimed at ensuring that students in examination classes are adequately prepared for the examinations. With the advances in teaching aid and learning objectives, teaching strategies have experienced a significant shift to meet individual student's needs and being more

interactive and activity-based learning through collaboration techniques that would require participation and engagement of learners. Thus, many strategies evolved as an attempt to fulfill the objectives of the learning process, by shifting the focus from instructor-driven to learner-centered teaching strategies.

The use of educational software, supported with appropriate teaching and learning strategies such as research-based learning (RBL) (Gelbart et al. 2009), problem-based learning (PBL) (Annetta et al. 2009) or inquiry-based learning (IBL) (Kyza et al. 2011) has a special importance in teaching and learning. All these strategies make the individualization of teaching possible, provide the individual knowledge, constant feedback and enable the monitoring of students' progress. By using some special techniques, the controlled function of teaching is realized, the teaching process is regulated and inner motivation for learning is encouraged (Mandić, 2010). Educational software would make it possible to make connections between the real-life phenomena and abstract models by presenting phenomena dynamically by using videos and animations. These representations could help students realize the dynamic nature of the phenomena, activate students' prior knowledge (Wu et al. 2013) and influence their performance in questioning, explaining and understanding concepts. Studying biology in this way develops the students' self-reliance in work, initiative freedom of choice, skillful discussions and the presentation of work results. Also, they need to be active participants in the teaching and learning process, so the learning environment must support active cooperative and autonomous learning. By the introduction of innovative didactic models in the process of teaching, modernization is achieved, the quality of teaching is improved and thus a lot of its social demands are fulfilled; for instance, its efficiency and rationalization. Keeping in mind the importance of biology for the education of a contemporary man, biology teaching must follow the modern trends.

Process-based instruction focuses upon developing students' independence in learning and problem solving by providing a framework into which curriculum activities can be placed. Therefore, it is important to implement teaching methods including both autonomous learning and instructional activities, and to vary the level of openness of experimental tasks. The implementation of problem-based active learning models has positive effects on students' academic achievements and their attitudes to science courses while implementation of problem-based learning and group investigations encourages students to think critically through planning, arguing, stating questions and problems, and providing solutions to environmental problems (Hillmayr, et al., 2020). Biological field-based activities such as fieldwork and field trips provide students with authentic and interactive experiences and experiential learning opportunities, which increase students' interest and enhance their learning but this strategy cannot be used during a pandemic like Covid-19 (Hart & Nolan, 2008).

1.2 Problem Statement

An organization should be able to adapt to any changes, including challenges and competitions that occur in its environment. The ability to adapt is essential for an organization to survive and expand. An organization's readiness for change is considered an essential factor in the ability to adapt (Manning, 2020). One challenge, however, is the unexpected external factor that requires an immediate organizational response. Covid-19 is one of those external factors that demanded change and adaptation across all fields in Ghana ranging from education, research, sports, entertainment, transportation, worship, social gathering or interactions, economy, businesses, and politics (Fitriyani et al. 2020). Indeed, the entire world was in distress as a result of Covid-19 threats, the reality of the situation was challenging to bear, and the education sector remains one of the worst-hit by the Covid-19 outbreak. The Covid-

19 pandemic disrupted teaching methods. Quentin (2014) states that school closing is very controversial, as it can have spillover effects on a large number of students in receiving schools. It can affect the quality of teaching and learning and academic achievement particularly for students with special needs or those with learning difficulties that often requires more physical attention and guidance from the teachers.

Furthermore, biological field-based activities, for example, fieldwork and field trips which provide students with authentic and interactive experiences and experiential learning opportunities which would increase students' interest and enhance their learning could not be used during a pandemic like Covid-19 (Hart & Nolan, 2008).

Based on that, biology teachers had to adapt rapidly to alternative ways of teaching. In biology education, selected teaching methods should support learning biology, learning to do biological science and learning about biological science. Several biological topics require approaches promoting experimental problem-solving and process-based skills. The focus is on science investigation processes and the goal is to reach valuable learning results, and students therefore need crucial science content knowledge as well as autonomous learning.

The Covid-19 pandemic changed the running of biology classrooms in the world especially where schools in advanced countries adopted an online system to deliver their lessons. The online teaching methods allowed schools to continue providing education to students remotely in order to ensure the continuation of learning despite school closures. However, this could not be said about schools in developing countries especially Senior High Schools. Therefore, the researcher deemed fit to explore the impact of Covid-19 pandemic on the teaching of biology in Senior High Schools in the Cape Coast Metropolis.

1.3 Purpose of the Study

The purpose of the study was to examine the impact of Covid-19 on the teaching of biology in Senior High Schools in the Cape Coast Metropolis of Ghana.

1.4 Objectives of the Study

The specific objectives of the study are to:

1. Investigate the impact of Covid-19 on the teaching of biology in Senior High Schools.
2. Investigate the teaching strategies adopted in the teaching of biology during Covid-19.
3. Investigate how these teaching strategies could be used effectively and efficiently during pandemic.

1.5 Research Questions

The following research questions will guide the study:

1. To what extent has Covid-19 pandemic impacted the teaching of biology in Senior High Schools?
2. Which teaching strategies were adopted to teach biology during Covid-19?
3. How could these teaching strategies be used effectively and efficiently during a pandemic?

1.6 Significance of the Study

This study will reveal the strategies that biology teachers used during the Covid-19 period. Also, it will reveal how the adopted teaching methods contributed to teaching and learning. Furthermore, it will bring out teaching methods that could be used effectively to teach even after the Covid-19 pandemic. This research contributes to the existing literature in the field of biology education on the impact of Covid-19 which

other scholars could use in relation to the global pandemic as well as providing relevant information to biology teachers on the teaching approaches that should be adopted to teach biology in Senior High Schools during a pandemic

1.7 Limitation of the Study

Some of the respondents did not return the questionnaires that were administered to them. Time constraints is another limitation to this thesis as working as a teacher in one of the Senior High Schools in Cape Coast whilst pursuing this project was not easy at all.

1.8 Delimitation of the Study

This study is delimited to only biology teachers in the Senior High Schools in the Cape Coast metropolis.



CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter discusses the literature related to the study presented under the following headings: Meaning and causes of Covid-19, impact of Covid-19 on teaching and learning of biology, application of ICT in teaching and learning, importance of ICT in teaching and learning, online learning(e-learning), challenges of online learning of biology, and theoretical framework of the study.

2.1 Covid-19

Covid-19 first appeared in Wuhan, China and was declared as pandemic by WHO officially on March 12, 2020 (WHO, 2020). Covid-19 is a severe acute respiratory syndrome and is a type of virus which spreads very quickly through physical contact such as the nose, mouth and eyes, and develops in the lungs. The signs and symptoms of Covid-19 are increased body temperature, fever, numbness, cough, pain in the throat, headache, difficulty breathing if the virus has reached the lungs (Syafrida, 2020). The Covid-19 pandemic affected educational systems worldwide as most countries temporarily closed down their educational institutions in an attempt to contain the spread of the virus. These nationwide closures impacted over 60% of the world's student population (Hofer, Nistor, & Scheibenzuber, 2021) . Several other countries have implemented localized closures affecting millions of additional learners (UNESCO, 2020). In Ghana, the education sector changed since cases of Covid-19 infections were detected in the country. They prematurely closed all schools and as a consequence compelled teachers to make a switch to a virtual environment, which requires the integration of technology into teaching instructions (Hodges, Moore,

Lockee, Trust, & Bond, 2020). It was necessary to change their approach in order to positively impact both the content elements and the students' perceptions. Biology teachers should be able to utilize technology to deliver biology curriculum, assess learners, direct them to research topics, and to use student-centered strategies integrated with technology (Ghaviferkr et al., 2012). Mulenga & Marbán (2020) explored how prospective teachers engage in online learning activities during the COVID-19 pandemic. The study proposed a comprehensive and advanced pedagogic design to render lessons through virtual classrooms during and beyond the Covid-19 age. Due to the Covid-19 crisis, researchers and educators around the world are trying to find possible alternatives that can work for students to have a paradigm shift from the face-to-face modes of learning to online education.

2.2 Impact of covid-19 on teaching strategies

Covid-19 pandemic outbreak contributed to the closure of schools and other educational institutions. It was estimated that 107 countries implemented educational institutes' closures and it affected approximately 862 million people around the globe which was calculated as half of the world students' population (Viner et al., 2020). School closure means the closing down of educational institution as a result of a pandemic, emergencies, labor strikes, disasters or deliberate efforts to reposition a school or curb crimes in a given campus or environment. This means that school closures are not only for emergencies or pandemics, but also a deliberate way of addressing some identified gaps in a given school. For instance, in Nigeria, the government or school authorities often shutdown schools to address security issues such as cultism, terrorism or violent protests on the campus. Gore (2021) reported that even though, school closures sometimes may be for good reasons, the recent school closures due to Covid-19 was detrimental to many educational systems across the world (Gore (2021). According to

Brummet (2014), school closures can either be reactive or proactive and they further stated that reactive closure of schools occur upon the discovery of Covid-19 cases among the students, staff or parents. While proactive school closure occurs before the disease even reaches the doors of the school. Consequently, it is important to admit that despite the perceived challenges imposed by school closures for the Covid-19, the option remained one of the most effective measures to halt the spread of the pandemic. School closures may result in increased rate of dropouts due to loss of interest and lack of resources to continue and if not properly curb, this could lead idleness which would contribute to negative peer influences and youth involvement in crimes. The UNESCO-UNICEF-World Bank Survey on National Education Responses to Covid-19 School Closures highlighted the need to not only monitor and mitigate students' learning losses but to also recognize the need to provide teachers with the training and support they need to transition to new modalities of instruction.

Wheatley (2014) opined that organizational change occurs through a change in meaning in a symbolic framework. When the status quo is disturbed, the individual organization will be encouraged to change its operation mode. In organizational theory, the symbolic framework describes the university as a culture (Bolman & Deal, 2013). To create university change using a symbolic framework, lecturers must undergo a cultural change that causes face-to-face learning to be abandoned as a "ritual" of the past for something more beneficial to current university realities, namely online learning. Universities started moving from traditional face-to-face education to remote education from March, 2020 by providing students with course materials and recorded lectures and these were sent through emails or uploaded on associated software platforms. This helped many universities to avoid compromising education in a pandemic situation (The News, 2020). Along with a shift of curricula from "content-

centered” to “competence-based”, the mode of curricula delivery has now shifted from “teacher centered” forms of delivery to “student-centered” forms of delivery. Problem-solving, which requires an inter-disciplinary approach, was one of the frequently used methods. Research activities were also negatively affected because school closures and lockdowns limited researchers’ ability to conduct researches particularly in situations whereby face-to-face interactions with students and teachers were required or access to school facilities or research laboratories were denied and therefore, school driven innovations and research were also greatly affected during school closures (Brummet (2014).

According to Muroga (2020), in order to mitigate the effects that accompanied the closures of schools, educators and learners had to rely on use of technological tools and platforms to ensure continued education. According to Windhiyana (2020), online learning is a form of learning that is implemented by utilizing an internet connection so that communication between educators and students is established without physical contact. According to Saputro (2020) online learning must remain oriented to the principles of learning outcomes and still pay attention to the accessibility abilities of students. In traditional class teaching, body language, eye contact, and physical gestures are significant teaching tools. However, in online teaching, teachers should focus more on their voices and vocal functions. Literature showed that effective communications between students and teachers are very important and, therefore, keeping voice pitch high and practicing vocal functioning like pauses and intensity variations are essential. A recent study suggested that speaking gently is beneficial for students as it helps them in writing essential lecture points (Bao, 2020). Online classes are completely different from the traditional in-class lectures. In traditional in-class lecture, teacher feels more control over student behavior. To deal with this concern, study shows that teachers

should devise different activities which can enhance students' learning skills in online classes (Bao, 2020). Moreover, teachers should also ask challenging questions from students during online classes as these practices will help instill better learning abilities in students and ensure that they are more focused in class (Smith, et al. 2004). Transition to online teaching has created various challenges not only for students but also for teachers who had to adjust the content and curriculum with respect to the education and activity of students. Additionally, remote teaching in biology is more difficult due to the experimental nature of the subject. Greater interactivity in online course will enhance the overall online class success rate. Literature depicts that more student and teacher discussion can result in higher interactivity (Townsend et al., 2002). Besides these, getting feedback from students about these online classes enhance the capacity of online learning.

2.2.1 Application of ICT in Teaching and Learning.

Computers and internet technologies enable new ways of teaching and learning rather than simply allowing teachers and students to do what they have done before in a better way. ICT has an impact not only on what students should learn, but it also plays a major role on how the students should learn. ICTs such as videos, television and multimedia computer software that combine text, sound, and colorful moving images can be used to provide challenging and authentic content that will engage students in the learning process. The teaching of biology requires creating a technology specific to its purposes; therefore, the equipment and objects that are used within the scope of biology education technologies should be determined specifically. These tools can be computers, software, film strips, written-printed materials, audio devices, radio and cassettes, TV, VCR, smart boards and telephones, internet technology devices. Interactive radio likewise makes use of sound effects, songs, dramatizations, comic skits, and other

performance conventions to compel the students to listen and become more involved in the lessons being delivered. Recent data show that over 90 per cent of education ministries worldwide have implemented some form of remote learning approaches that involve radio, television or the internet (UNICEF, 2020; UNESCO, UNICEF and World Bank, 2020; Dreesen et al., 2020). While no remote learning technology can completely replace the classroom learning experience, some technologies have features that allow them to better emulate classroom settings. TV and radio require programs to be pre-recorded and made live, interactive lessons difficult. In contrast, digital technology such as the internet, personal computers, tablets and mobile phones may be more suitable for emulating classroom-like interactions.

Putri et al., (2020) stated that along with the times, a person can get information easily through new technologies that continue to develop. This technological development can be beneficial in the field of education for both teachers and students. From the students' perspective, science is a lesson that is boring and difficult and therefore, teaching activities should be shaped by using computer-assisted software and effective digital learning materials (Bayturan, 2011). In this context, it is imperative to strengthen the hardware infrastructure of the schools and the development of biology software to increase the importance of computer-assisted biology teaching every day.

Borrowing a biological metaphor offered by Morgan (2006), we try to understand the university's shift to online learning during the Covid-19 pandemic. In this context, universities can be characterized as organisms that need food from their environment, so universities need to develop the right relationship with the environment for learning continuity and technology provided the opportunity for most institutions during the Covid-19 pandemic.

2.2.2 Importance of ICT in Teaching and Learning

One of the most vital contributions of ICT in the field of education is easy access to Learning. With the help of ICT, students can now browse through e-books, sample examination papers, etc., and can also have an easy access to resource persons, mentors, experts, researchers, professionals, and peers-all over the world. This flexibility has heightened the availability of just-in-time learning and provided learning opportunities for many more learners who previously were constrained by other commitments (Young, 2002). Internet connectivity can increase learner motivation as it combines the media richness and interactivity of other ICTs with the opportunity to connect with real people and to participate in real world events. ICT enhanced learning is student-directed and diagnostic. Unlike static, text or print-based educational technologies, ICT enhanced learning recognizes that there are many different learning pathways and many different articulations of knowledge. ICTs allow learners to explore and discover rather than teacher centered approach of merely 'listen and remember'. ICT can engage and inspire students, and this has been cited as a factor influencing ready adaptors of ICT (Long, 2001; Wood, 2004). The World Wide Web (www) also provides a virtual international gallery for students' work (Loveless, 2003). Learning process is different in digital media and the new generations are more interconnected and better informed. Due to positive impact of digital media, it is very easy to work as a group for project assignments by using social networking. Students make different groups on different social networks like WhatsApp, twitter; Facebook and email to share input regarding to the assignment. Learning approaches using contemporary ICTs provide many opportunities for constructivist learning and support for resource based, student centered settings and by enabling learning to be related to context and to practice (Berge, 2008; Barron, 2005). Teachers could make their lecture more attractive and

livelier by using multi-media which would enable students to capture the lessons taught them easily, retained them for a longer span as well as to track students' progress in real life.

2.2.3 Online Learning (E- Learning)

The development of education in this era cannot be separated from the desire of all education practitioners to improve the quality of teaching as an effort to advance education. To modernize education is one aspect that determines good teaching methods by teachers (educators) to create super generation (Simbolon, 2017). The development of information technology has a major influence on changes in every field and one of the areas is the field of education. Technology can be used in teaching and learning activities, which can be said to be a change from conventional to modern. The presence of technology has many positive effects on learning as the internet has been integrated into a tool used to complement learning activities. Online learning is a learning system that is carried out not face-to-face, but using a platform that can help the teaching and learning process that is carried out even though it is a distance. Online learning can be defined as a teaching and learning activity that utilizes a network or internet connection so that communication is established between the teacher and students without involving physical contact. According to Fitriyani et al., (2020), online learning is an educational innovation that involves elements of information technology in learning. According to Windhiyana (2020) online learning is a learning that is implemented by utilizing an internet connection so that communication between educators and learners is established without physical contact. With e-learning, teaching participants (learners) do not need to sit nicely in the classroom to listen to every word of a teacher directly. Saputro (2020) opined that online learning must

remain oriented to the principle of learning outcomes and still pay attention to the accessibility abilities of students.

The purpose of online learning is to provide quality learning services in a network that is massive and open to reach more and wider learning space enthusiasts (Handarini, 2020). Putri et al., (2020) stated that along with the times, a person can get information easily through new technologies that continue to develop. This technological development can be beneficial in the field of education for both teachers and students. Some of the benefits of e-learning includes: by being able to shorten learning time or be more practical and making lesson costs more economical, e-learning can also facilitate student interaction with the materials at a time until it is repeated, and e-learning is a knowledge development process that does not only occur in the classroom, but outside the classroom or at home(study at home) with the help of technology, equipment and internet networks, so students can be actively involved in the teaching-learning process (Rohmah,2016).

2.2.4 Challenges of Online Learning

School closures for Covid-19 did not only increased pressures on students, teachers and parents especially those with limited digital skills, education and resources for continued education but also increased burden on parents not only to struggle to provide for their homes, but also to perform the supervision task of ensuring that their children learn from home. Purwanto et al., (2020) revealed some of the challenges and obstacles experienced by students, teachers and parents in online learning. Challenges related to students are limited communication and outreach among students, higher challenges for students with special educational needs. According to Putri at al., (2020), teachers identify more challenges and obstacles such as restrictions in the choice of teaching methods that usually apply in regular face-to-face classes, less curriculum material

coverage, lack of technological skills that hinder the potential for online learning, more time needed to develop e-content, longer screen times as a result of creating e-content as well as providing feedback on students work and higher internet bills. For universities, it was a challenging task to move all face-to-face courses to remote learning. In other words, transforming to remote learning in such a short period of time was difficult especially, in developing countries, where technology advancements are not practiced much. Lesson plan, teaching materials (both audio and video), relevant software installation and technology support all are mandatory steps for running an online course, (Academia, 2020). Furthermore, literature proves that lack of IT infrastructure, insufficient IT knowledge of faculty members as well as poor internet services are major issues to remote learning (Rafiq et al., 2020). Though, Pakistani universities have internet and equipment facilities available on campuses yet it is difficult for them to provide student with these resources at their residences. Not only internet access, but also availability of broadband services is also difficult. According to Zahra et al., (2020) it was a difficult task to do online teaching and learning for both students and teachers because online classes in the time of Covid-19 were expensive. Rural inhabitants have dramatically less access to adequate education, internet and communications technology. In rural areas most of the people are related to agriculture and majority are dependent on hand to mouth income. Therefore, they are not able to afford extra expenses of their children study. On the other hand, if some people are able to afford these expenses but due to internet service students are not able to attend online classes properly. So, the major issue for rural area student is the low-quality internet service. Van der Spoel et al., (2019) noted that the absence of interaction is the main negative aspect of remote teaching. The perception of transactional distance weakens communication between the teacher and student in various environments and creates a

psychological divide while Amhag et al., (2020) concluded that the absence of direct interaction has helped integrate introverted students into the learning process in more significant ways compared to the standard teaching style.

2.3 Theoretical Framework of the study

Theoretical framework shows that research does not just come out of the blue, but rather, it is both grounded in and based on scientific theory Vinz (2015). The researcher employed the constructivism approach teaching method in this work. Constructivist approach teaching method is based on constructivist learning theory which is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information (Jonassen et al., 2003). As such, children are not to be treated as a blank slate, but rather allow to make sense of classroom materials in the context of his or her current knowledge and therefore, the individual is consciously engaged in the construction of a product (Lu, 2007). The utilization of constructivism in educational settings has been shown to promote higher-order thinking skills such as problem-solving and critical thinking (Lu, 2007). Information may be imposed, but understanding cannot, for it must come from within and so constructivism requires a teacher to act as a facilitator whose main function is to help students become active participants in their learning and make meaningful connections between prior knowledge, new knowledge, and the processes involved in learning. Constructivism classroom, is no longer a place where the teacher ("expert") pours knowledge into passive students, who wait like empty vessels to be filled but the students are urged to be actively involved in their own process of learning whilst the teacher function as a facilitator who coaches, mediates, prompts, and helps students develop and assess their understanding, and thereby their learning. Teachers provide students with experiences that allow them to hypothesize, predict, manipulate

objects, pose questions, research, investigate, imagine, and invent. Teachers who are committed to learner-centered education seek to challenge students within their abilities while providing encouragement and recognition of student success. The purpose of learning is to construct one's own meaning, and not having the "right" answers by repeating someone else's meaning. Active engagement should involve enquiry, exploration, questioning, debates, application and reflection and creation of ideas. The engagement of learners through relevant activities can further facilitate the construction of mental images of the relationships (cause and effect). Allowing students to ask questions that require them to relate what they are observing in school and outside the school. Teachers must understand the mental models that students use to comprehend the world, and the assumptions that support those models in order to teach well.

2.3.1 Cognitive Constructivism

Piaget (1977) asserted that learning occurs by an active construction of meaning, rather than by passive recipient. Piaget called his view constructivism, because he firmly believed that knowledge acquisition is a process of continuous self- construction. That is, knowledge is not out there, external to the child and waiting to be discovered. But rather it is wholly performed within the child, ready to emerge as the child develops within the world surrounding her or him. Cognitive constructivism emphasizes that knowledge acquisition is an adaptive process which results from the active engagement by the individual learner and knowledge then, from the cognitive constructivist position, is the result of the accurate internalization and reconstruction of external reality. The results of these internalization processes are cognitive processes and structures that accurately correspond to processes and structures that exist in the real world. Children learn through two processes: assimilation and accommodation. Assimilation is defined as dealing with a new event in a way that is consistent with an

existing schema. That's assimilation occurs when a new information is added into an existing schema and for example, a toddler may assimilate a new ball into the schema of toys that can be thrown or a second grader may assimilate a new furry animal seen at the zoo into his or her animals that are mammal's schema. Accommodation is the process of dealing with new information or event by modifying an existing schema or forming a new one. That's accommodation occurs when new information counteracts with existing schema and this information with a schema, needs to be modified or a new schema needs to be created. For example, the toddler may realize that the new ball is too heavy to be thrown, so he may have to roll it, thereby modifying his existing schema of all-toy-balls-can-be-thrown. Or the child at the zoo may note that the furry animal is flying and create a new schema of animals.

Juniu (2006) believed that learning proceeded by the interplay of assimilation (adjusting new experiences to fit prior concepts) and accommodation (adjusting concepts to fit new experiences). The to-and-fro of these two processes leads not only to short-term learning, but also to long-term developmental change. He explained that when learners encounter an experience or a situation that conflicts with their current way of thinking, a state of disequilibrium or imbalance is created, therefore, they must then alter their thinking to restore equilibrium or balance. To do this, they make sense of the new information by associating it with what they already know, that is, by attempting to assimilate it into their existing knowledge. When they are unable to do this, they accommodate the new information to their old way of thinking by restructuring their present knowledge to a higher level of thinking. Learning, therefore, is simply the process of adjusting our mental models to accommodate new experiences. Cognitive equilibrium occurs when a person's environment and knowledge base match and equilibrium is achieved after the course of assimilation and accommodation.

Equilibrium is broken when a new stimulus or a new event occurs and is called disequilibrium. Disequilibrium is a cognitive state that occurs when a person's physical environment and knowledge base do not match. Teachers must therefore; help learners to eliminate any form of disequilibrium and accommodate new information to their old way of thinking by restructuring their present knowledge to a higher level of thinking.

2.3.2 Empirical Knowledge

Jean Piaget believed that humans are not born as “blank slates” but instead are born with instinctual abilities that allow them to interact with their environment and gain knowledge. Humans are born with senses, including taste, touch, sight, hearing and smell, which they use to explore and actively react to their surroundings. That's humans have a “built-in blueprint” that dictates their learning. Wadsworth (2007) discovered a type of knowledge acquisition called physical knowledge (empirical knowledge), which has to do with knowledge about the world, which can be gained through perceptual properties. That's physical knowledge refers to knowledge related to objects in the world, which can be acquired through perceptual properties (Oliver, 2005). Empirical knowledge is related to Piaget sensor motor stage of development. The sensor motor stage is the period when infants “think” by means of their senses and motor actions. As learners interact, touch, manipulate, listen to, these actions allow them to learn about the world as these actions help them to construct simple concepts of objects and events. According to Bonk et al. (2009), experimenting and manipulating physical objects is the main way children learn, for example experimenting in the laboratory is a way to develop a child's knowledge that's, learners construct knowledge from their experiences and observations. Piaget believed that children actively approach their environments and acquire knowledge through their actions.

2.3.3. Social Knowledge.

Social knowledge is a culture-specific and can be learned only from other people within one's cultural group. That is, knowledge is created through experiences and interactions that occur within one's environment as knowledge is a process, not a product and occurs continuously (Mayer, 2003). Without social interactions, knowledge would remain static and so social environment is also critical for cognitive development. Social interactions allow for multiple perspectives, opinions and introduction of new ways to approach a task or event. The social constructivist classroom helps students to build their knowledge and to control the existence of students during the learning process in the classroom. The Association for Constructivist Teaching (ACT, 2007), states that the social constructivist teacher is one who values learner reflection and cognitive conflict and encourages peer interaction. According to Kompf (2006) constructivist teachers allow student responses to drive lessons, shift instructional strategies, and alter content. According to Ndon (2011) a teacher as a facilitator, should provide rich environments, experiences, and activities for learning by incorporating opportunities for collaborative work, problem solving, authentic tasks. The teacher, therefore, should concentrate on students' learning rather than on teacher performance.

2.3.4 Constructivist Teaching Strategies

There are many constructivist teaching strategies suggested to change and improve students understanding during teaching of concepts in science (Clement, 2007). Scott et al., (2002) identified two main groups of teaching approaches that promote conceptual change in students. The first group consists of strategies that are based on cognitive conflict and the resolution of the conflicting perspectives which is derived from Piagetian's view of learning in which learners' active participation in reorganizing

their knowledge is central. Students are made conscious about their own opinions and then an opposite event or some activities that challenge their own opinions are given. Examples of such strategies are the predict-observe-explain (POE) developed by Gunstone (2002) and learning cycle developed by Karplus (1967). The second group consists of strategies which build on students' existing ideas and opinions and spread them through for example, an analogy or a metaphor to a new domain. According to Scott et al., (2002), the strategies which build on learners' existing knowledge schemes, extending them to new domains, may be seen to place less emphasis on the role of accommodation by the learner and instead focus on the design of appropriate interventions by the teachers to provide 'scaffolding' for new ways of thinking. The learning cycle introduced by Karplus in 1967 for the Science Curriculum Improvement Study (SCIS), has evolved into one of the most important teaching approaches in science education (Turkmen, 2006).

The learning cycle approach is an inquiry-based learning and its goal is to enhance learning and provide students with more authentic science experiences that imitate those real scientists and are in accordance with the nature of science (Turkmen, 2006). Marek et al., (2003) stated that the learning cycle is a specific organization of phases dominated by the integrity of the whole and the relationships of the phases to each other for experiencing science by inquiry and for organizing science curricula. This approach is a student-centered teaching procedure which offers another way of teaching science concepts in which students learn from their experiences, rather than through other learning methods that rely on the textbook for classroom learning (Fleener, 2006). Inquiry-based learning is an educational approach associated with problem-based learning in which the student learns through investigating issues or scenarios (Hakverdi-Can & Sonmez, 2012). Inquiry can be defined as a search for information, a

quest for knowledge, or an exploration of certain phenomena to understand the world better (Marek & Cavallo, 2007). The critical element of inquiry is that students seek answers to questions and not teachers providing answers to questions. True learning comes from investigation, resulting in summarizing, evaluating, and communication of findings and examination for known facts and theories; this is the essence of inquiry (Holgan et al., 2000). The process of inquiry begins with gathering information and data through applying the human senses: seeing, hearing, touching, tasting, and smelling (Colburn, 2002). In this approach, students pose and answer questions individually and/or collaboratively in order to draw conclusions regarding the specific issues or scenarios (Zembylas, 2005). Within the educational setting, inquiry-based learning has been beneficial in developing student inquiry, investigation, and collaboration skills, in turn, increasing overall comprehension of the issue or scenario (Hakverdi-Can & Sonmez, 2012).

Problem-based learning is a structured educational approach which consists of large and small group discussions (Schmidt et al., 2007). Problem-based learning begins with an educator presenting a series of carefully constructed problems or issues to small groups of students and the problems or issues typically pertain to phenomena or events to which students possess limited prior knowledge (Schmidt et al., 2007). The first component of problem-based learning is to discuss prior knowledge and ask questions related to the specific problems or issues. Within the educational setting, problem-based learning has enabled students to actively construct individual understandings of a topic using both prior and newly acquired knowledge. Moreover, students also develop self-directed and group learning skills which ultimately facilitates the comprehension of the problems or issues (Özmen, 2004). Anchored instruction is an educational approach associated with problem-based learning in which the educator introduces an 'anchor' or

theme in which students will be able to explore (Kariuki et al., 2004). The 'anchor' acts as a focal point for the entire task, allowing students to identify, define, and explore problems while exploring the topic from a variety of different perspectives (Kariuki, et al., 2004). The 5-E learning cycle is also a model consisting of: engage, explore, explain, elaborate and evaluate (Yilmaz et al., 2006) Figure 1.

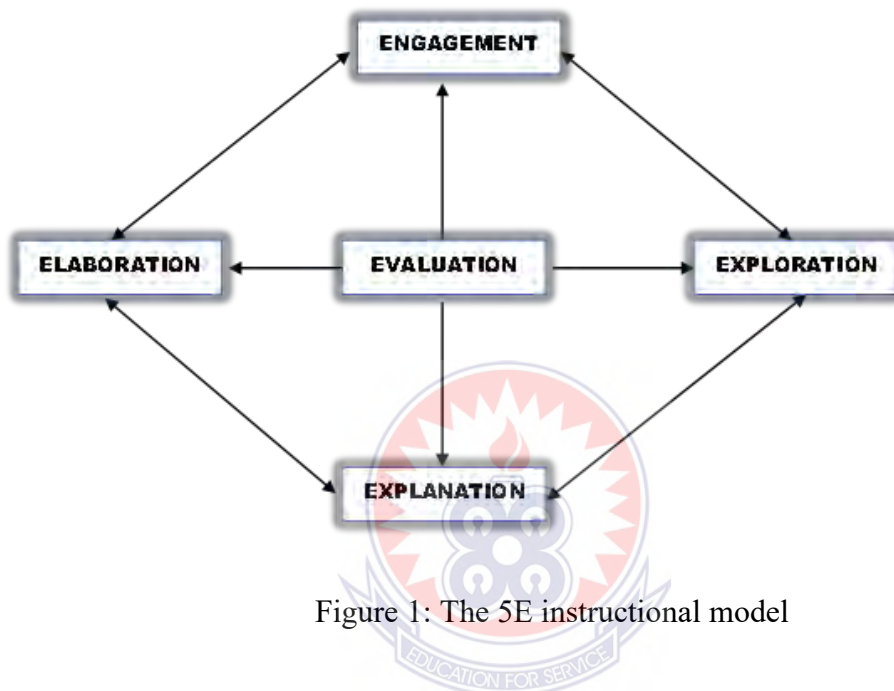


Figure 1: The 5E instructional model

Engagement

In this first phase of the cycle, the teacher aims to assess student prior knowledge and/or identify possible misconceptions. This student-centered phase should be a motivational period that can create a desire to learn more about the upcoming topic. Students may brainstorm an opening question or ask themselves: What do I already know about this topic? Discrepant events, demonstrations, questioning, or graphic organizers such as KWL (know, want, and learn) charts may be included to create interest or generate curiosity. A KWL chart asks students to brainstorm and record what they know, want to know, and eventually have learned about the topic. The know, want and learn (KWL)

chart is used to pre-assess student prior knowledge and is oftentimes referred to throughout the duration of the lesson (Hanuscin & Lee, 2007).

Exploration

Following an engagement phase that promotes a mental focus on the concept, the exploration phase now provides the students with a common, concrete learning experience. This phase is also student-centered and incorporates active exploration. Students are encouraged to apply process skills, such as observing, questioning, investigating, testing predictions, hypothesizing, and communicating, with other peers. This phase of the learning cycle tends to incorporate the main inquiry-based activity or experience, which encourages students to develop skills and concepts. The teacher's role is one of facilitator or consultant and students are encouraged to work in a cooperative learning environment without direct instruction from the teacher. This phase is also unique because the students are given a "hands-on" experience before any formal explanation of terms, definitions, or concepts are discussed or explained by the teacher.

Explanation

A "minds-on" phase follows the exploration phase, and this is more teacher-directed and guided by the students' prior experience during the exploration phase. The explanation phase enables students to describe their understanding and pose questions about the concepts they have been exploring. It is likely that new questions will be generated. The explanation phase is an essential, minds-on part of the 5E lesson. Before the teacher attempts to provide an explanation, the students must first have the opportunity to express their own explanations and ideas. Thus, the initial part of the

explanation phase is a time for the teacher to serve as a facilitator and ask the students to describe and discuss their exploration learning experiences. After the students have had the opportunity to share their own explanations, the teacher introduces scientific and technical information in a direct manner. This phase includes clarification of student misconceptions that may have emerged during the engagement or exploration phases. Formal definitions, notes, and labels are provided. The teacher may also decide to integrate video, computer software programs, or other visual aides to help with student understanding. The students should then be able to clearly explain the important concepts to the teacher and to their peers.

Elaboration

The activities in this phase of the learning cycle should encourage students to apply their new understanding of concepts, while reinforcing new skills. Students are encouraged to check for understanding with their peers, or to design new experiments or models based on the new skills or concepts they have acquired. The goal of this phase is to help develop deeper and broader understandings of the concepts. Students may conduct additional investigations, develop products, share information and ideas, or apply their knowledge and skills to other disciplines. This is a great opportunity to integrate science with other content areas. Elaboration activities may also integrate technology, such as web-based research or Web Quests

Evaluation

Assessment in an inquiry-based setting is very different to that in traditional science lessons. Both formal and informal assessment approaches are appropriate, and should be included. For instance, the use of non-traditional forms of assessment, such as portfolios, performance-based assessment, concept maps, physical models, or journal logs may serve as significant evidence of student learning. During an inquiry-based

lesson, assessment should be viewed as an ongoing process, with teachers making observations of their students as they apply new concepts and skills and looking for evidence that the students have changed or modified their thinking. Students may also have the opportunity to conduct self-assessment or peer-assessment. However, the evaluation may also include a summative experience such as a quiz, exam, or writing assignment.

The five-phase learning cycle directly corresponds to the Piagetian principles of assimilation, accommodation, and organization. According to Renner, Abraham, and Birnie (2005) "exploration phase of the learning cycle provides experiences leading to assimilation and disequilibrium", because, when information received from the outside world is different from the mental structure, the students do not make enough sense of it in their minds, and so students would reach a state of disequilibrium, but if the information fits the external reality to their existing cognitive structure, they can easily assimilate it in their mind (i.e. students are in the equilibrium phase). Marek et al., (2000) pointed out that here students have experienced or assimilated the essence of the concept and so activities and materials are supplied by the teacher and the role of the teacher is just to encourage students and give them some suggestions to maintain an appropriate level of disequilibrium. The teacher takes an active role in presenting the concept and students redefine, change, or invent mental structures at this point. Students will be in the accommodation phase in this learning cycle stage, because students make their own meaning out of the observations. Either they succeed to make adjustments in each mental structure to make it fit their experience, or they do not construct the new mental structure and then fail in the disequilibrium phase again. Generally, accommodation phase will occur during the class discussion. In the concept application stage, students continue to expand the concept by conducting more activities and using

additional resources for investigation. Students are instructed to collect data and then try to get concept by their own knowledge (Renner et al., 2006). In other words, explanation and investigation of concept, which is the use of evidence to back up conclusions, and the designing of experiments, are emphasized in learning cycle approach. Whereas the development of skills and techniques that are receiving of information and knowing of the outcome of an experiment before 'doing it is emphasized in the traditional teaching method. According to Turkmen (2006) the learning cycle approach is a better way to teach science than the traditional methods because "students feel more secured, and believe they have learned more since they experienced it" and that in the learning cycle teachers spend up to 90% of class time actively involve with their students, whereas in the traditional method, teachers spend approximately 7% of class time with their students. Turkmen (2006) argued that the traditional teaching method utilized by many teachers in teaching only serves as information-giving to passive students and that only 20% of the students retain what the teacher discussed after the lecture. This means that students who have memorized facts, principles, or any specific kind of knowledge without experiencing and developing concepts for themselves have not been taught science. In this perspective, the learning cycle approach is the best solution, because teachers using the learning cycle approach in their science classrooms allow their students to experiment and develop concepts for themselves. However, the teacher will need to devote more time to the preparation of materials. Again, the learning cycle approach is an effective tool for teaching science, which promotes the rational development of students while allowing them to understand science's inherent characteristics. Lu et al., (2007) opined that the learning cycle is an effective approach which would help students developed more positive attitudes toward science and science instruction than other approaches.

According to Turkmen (2006) the five-phase learning cycle approach should be reinforced throughout the science curriculum and should be used in context at every grade level. The teacher's main role in the learning cycle approach is to create social and intellectual climates, where collaborative, cooperative, constructivist and other learning methods are supported and also to provide contexts for students to think critically, explore phenomena in their everyday lives, and solve meaningful problems meaningfully.



CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter presents the procedures and the methods the researcher employed to carry out the study. The chapter comprises the research design, study population, sampling procedures, data collecting instruments, validity and reliability of the instruments, and methods of data collection and analysis

3.1 Study Area

The research was conducted in ten Senior High Schools in the Cape Coast Metropolitan Assembly (figure 2) Central Region in the Republic of Ghana. The traditional name of Cape Coast 'Oguaa' originates from the Fante word 'gua' meaning market. It was named Cabo Corso by the Portuguese meaning Short Cape and later on modified to Cape Coast by the British. The Cape Coast Metropolitan Area is one of the oldest districts in Ghana. It was raised to the status of municipality in 1987 by LI 1373 and upgraded to metropolitan status in 2007 by LI 1927. Cape Coast is blessed with many schools across the length and breadth of the Metropolis, ranging from basic to tertiary institutions. This study was conducted in ten senior high schools namely: Oguaa Senior High Technical School [OSTECH], University Practice Senior High School [UP SHS], Ghana National College [GNC], and Academy of Christ the King Senior High School [ACK SHS], Holy Child, Adisadel College (Adisco), Mfantshipim senior high school (Botwe), St. Augustine College, Wesley Girls Senior High School and Aggrey memorial senior high school. The researcher selected Cape Coast because this Metropolis has all the categories of Senior High Schools and this would have a fair

representation in the study, since the findings of the study can be applicable to every class of school and could also be generalized.

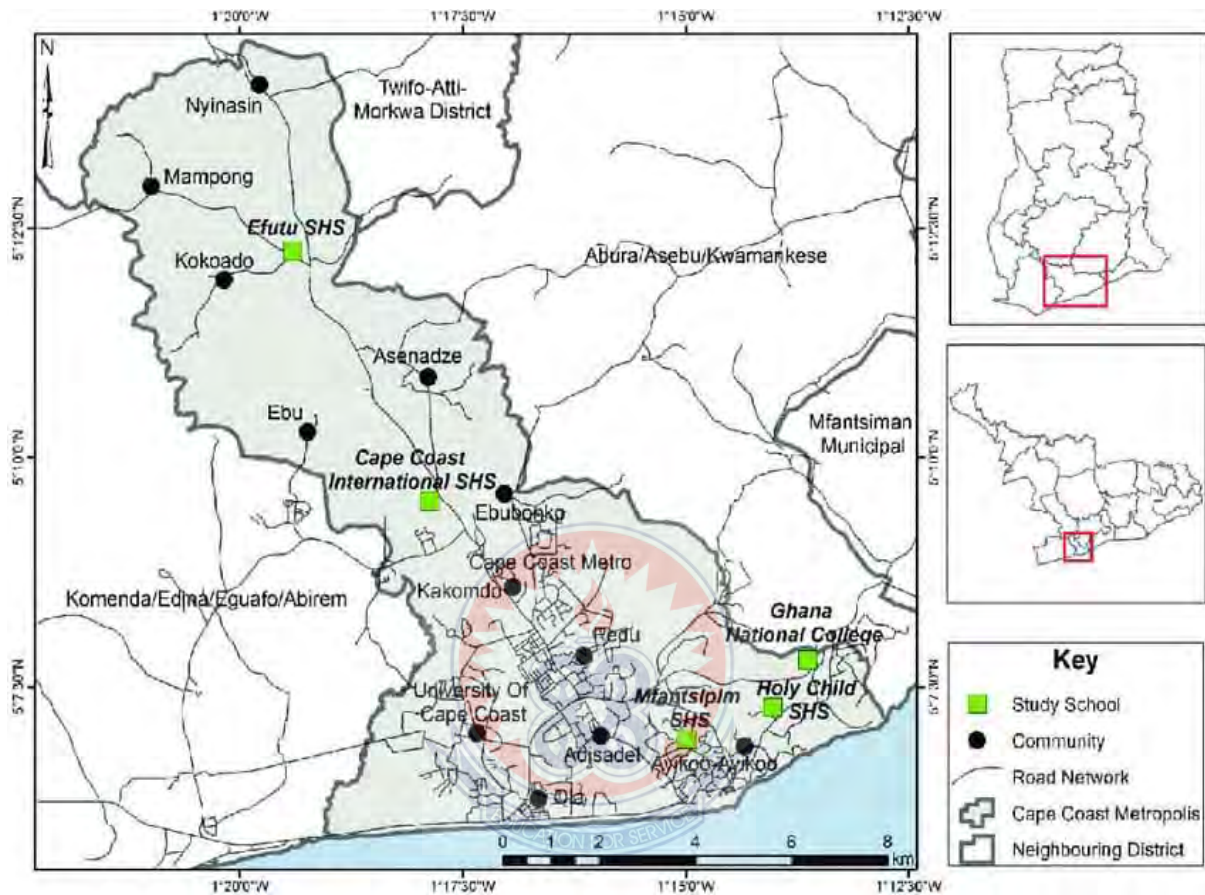


Fig. 2: Map of the study area showing the sampling locations.

3.2 Research Design

Creswell (2014) holds that the research design refers to the overall strategy that the researcher employs to integrate the different components of the study coherently and logically, thereby, ensuring he or she effectively addresses the research problem. That is, it constitutes the blueprint for the collection, and analysis of data. This study sought to investigate the impact of Covid-19 on biology teaching strategies in Senior High Schools. In effect, the study used a descriptive survey design. Descriptive research is a

purposive process of gathering, analyzing, classifying and tabulating data about prevailing conditions, practices, beliefs, processes, trends and cause effect relationships and making adequate and accurate interpretation about such data with or without the aid of statistical methods (Creswell, 2014). This design was adopted because it probed into the teachers' perception about Covid-19 and its effects on teaching of biology in Senior High Schools. .

3.3 Population

For any study, the target population is all the members of a group defined by the researcher's specific interest; to answer research questions and to whom the findings of a study may be generalized. The target population of this study comprised all biology teachers in the public Senior High Schools in the Cape Coast Metropolis. The accessible population, however, comprised of biology teachers in ten schools, Adisadel College, Wesley Girls, Holy Child, Ogua Secondary Technical School, St. Augustine's College, University Practice Senior High School, Ghana National College, and Academy of Christ the King Senior High School, Aggrey Memorial SHS, and Mfantsipim Senior High School. The accessible population of the study was about 200.

3.4 Sample and Sampling Techniques

Ten public Senior High Schools, Adisadel College, Wesley Girls, Holy Child, Ogua Secondary Technical School, St. Augustine's College, University Practice Senior High School, Ghana National College, and Academy of Christ the King Senior High School, Aggrey Memorial SHS, and Mfantsipim Senior High School were randomly selected with the aid of computer-generated numbers to take part in the study. Also, computer generated numbers were employed to select ten biology teachers from each school. In total, one hundred biology teachers were selected from the schools to form the sample

of the study. Thus, in total, 100 participants formed the sample for the study. Out of the 100 biology teachers selected for this study, fifty-six (56) were males whiles forty-four (44) were female.

3.5 Research Instruments

In this study, questionnaires were used as the main tools for data collection. The selection of this tool was guided by the nature of the data to be collected.

3.5.1. Questionnaire

Questionnaires are thought to be appropriate in helping the researcher to gather a large amount of data from many subjects economically. Questionnaires were used since the study was concerned with variables that could not be directly observed such as the views, opinions, perceptions and feelings of the respondents. Such information was best collected through questionnaires (Cohen, Manion & Morrison, 2018). According to Cohen Manion and Morrison, a questionnaire is a collection of written questions which are usually answered to obtain information from the respondents. The purpose of using the questionnaire was to enable the participants to answer questions freely as they respond to the questions. This instrument was necessary for this study as the respondents would have time to provide well thought answers. The questionnaire consisted of open-ended and closed ended items (Appendix A). These aimed at collecting information about the impact of Covid-19 on biology teaching strategy in senior high schools. The questionnaire consisted of five sections. The first section collected demographic data relating to sex, years of teaching experience. The second section sought information on technology used and practices adopted during Covid-19; proficiency in virtual technology and teaching methods and assessment technologies used during Covid-19. The third section collected data on the impact of Covid-19 on

teaching of biology during Covid-19. The fourth section gathered data on teaching strategies adopted to teach biology during Covid-19. The final section collected data on how the teaching strategies could be used effectively and efficiently during a pandemic. The items in the questionnaire were Likert-type items. Each item contained a statement followed by four or five suggested options; strongly agreed (= 1), agreed (= 2), undecided (= 3), disagreed (= 4) and strongly disagreed (=5) and also, very confident (= 1), confident (= 2), neutral (= 3), not confident (= 4), and not confident at all (= 5). The participants were required to place tick against the option that best expressed their opinion about the item.

3.6 Validity of the Instruments

Validity refers to the degree to which an instrument measures what it is supposed to measure. According to Cohen, Manion and Morrison (2018), validity can be determined by using a panel of persons who shall judge how well the instruments meet the standard. The content validity of the data collecting instruments was done by the experts in the field of biology education who proof read and provided necessary suggestions. Colleague biology teachers were further requested to rate the ability of each item in the instruments to measure and elicit anticipated data. They were also requested to indicate if the required data was meaningfully related to the stated research questions and objectives. The validity of the instruments was further verified during a pilot study. Suggestions offered by assessors were used by the researcher to modify the instruments to make them more adaptable to the study.

3.7 Reliability of the Instruments

Reliability is the measure of the degree to which an instrument yields consistent results or data after repeated trials (Creswell, 2014). To ensure the reliability of the data collecting instruments, the first draft of the instrument was presented to a few

colleagues for their opinion and suggestions on the format, content and other related issues. Their opinions and suggestions were incorporated into the final draft of the instrument. The Cronbach's alpha method of determining reliability was used to compute the reliability coefficient of the questionnaire items. A reliability coefficient (r) of 0.92 was obtained which indicated reliable data. Creswell (2014) asserted that in research, a reliability coefficient of 0.8 or more would imply that there was a highly reliable data.

3.8 Data Collection

The researcher obtained a research permit from the School of Graduate Studies [SGS], University of Education, Winneba. Permission from the school administrative leadership for each of the schools that participated in this study was sought to visit schools and contact teachers. The ten schools were visited by the researcher who then informed teachers about the study and made more arrangements for the researcher's visit. The researcher then re-visited the schools and administered the questionnaires to the biology teachers. The respondents were guided to respond to their questionnaires immediately after administration. The researcher allowed two weeks for the teachers to respond to the questionnaires administered to them, after which time the researcher returned to the schools to collect the teachers' questionnaires.

3.9 Data Analysis

Creswell (2014) explained that data analysis involves organizing what we have observed, heard and read, to make sense of the acquired knowledge. He maintained that as one does so he/she categorizes, synthesizes, searches for patterns and interprets the data collected. Cohen Manion and Morrison (2018) defined data analysis as a systematic process involved in working with data, organizing and breaking them into manageable units. It is also concerned with synthesizing data, searching patterns,

discovering what is important, what is to be learned and deciding what to tell others. Upon successful collection of data, the researcher organized the quantitative data systematically in frequency tables. Thereafter, the data code sheet was prepared and coded in the statistical package for social sciences [SPSS] software. In this study, the quantitative data was analyzed using descriptive statistics (frequencies, means, modes and percentages).

3.10 Ethical Considerations

Gray (2019) emphasizes on the need for the researcher to observe the principle of ethics when conducting educational research. While this research intended to contribute on the impact of Covid-19 on biology teaching strategies in selected Senior High Schools, it maintained the utmost confidentiality of the respondents. The researcher explained to the respondents the importance of data to be collected. They were informed that all data in the questionnaires would be treated with confidentiality. Where necessary, clarification was made on the items of the questionnaire. The respondents were not required to indicate their names on the questionnaire and the researcher ensured that all respondents were given free will to participate and contribute voluntarily to the study. Besides, the researcher ensured that relevant authorities were consulted and permission granted. The consent of the respondents was sought before commencing data collection.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Overview

This chapter presents the results of the study and discussed the findings from the study. The first part discussed the demographic information of the respondents, the second part discussed findings on the technology used and practices adopted during Covid-19; proficiency in virtual technology and teaching methods and assessment technologies used during Covid-19. The third section discussed the impact of Covid-19 on teaching of biology during Covid-19 in Senior High Schools, the fourth part discussed findings on the teaching strategies adopted during Covid-19. The final part of this chapter discussed findings on how these teaching strategies could be used effectively and efficiently during a pandemic.

4.1 Demographic Characteristics

This section describes the general background information about respondents (biology teachers). One hundred biology teachers were conveniently selected from the schools to form the sample of the study. Ten biology teachers were selected from each of these schools: GNC, Oguaa SHTS, University Practice (SHS), St. Augustine's College, Adisadel College, Holy Child, ACK SHS, Wesley Girls, Aggrey Memorial SHS, and St. Augustine college. Thus, in total, 100 participants formed the sample for the study.

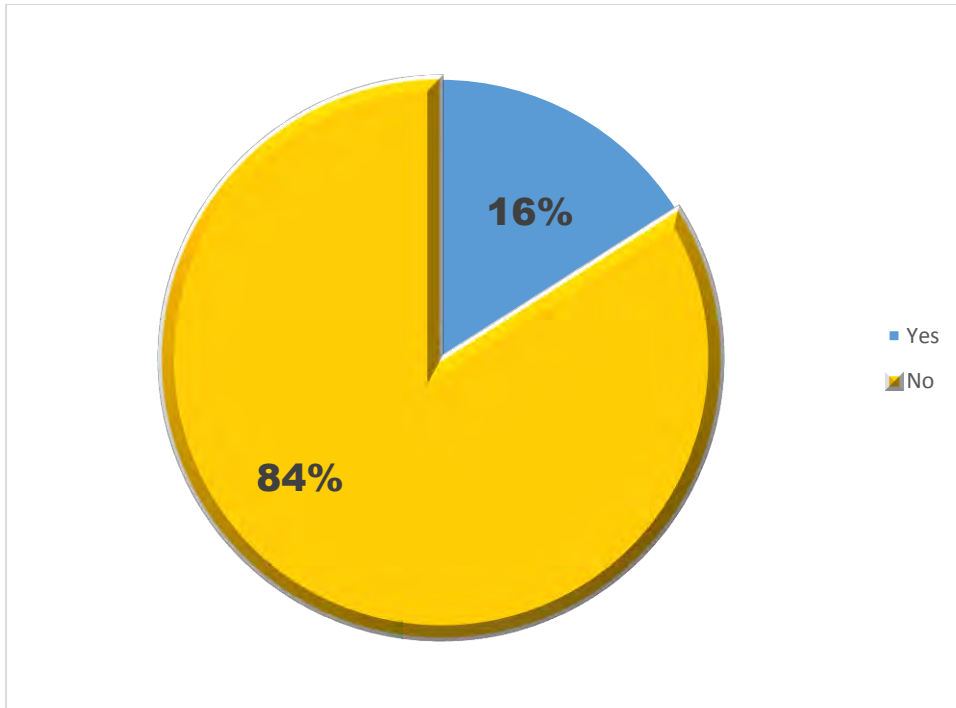
Table 4.1: Information on respondents teaching experience(N=100)

Variable	N	%
Teaching experience		
2-5 Years	33	33.0
6-10 Years	29	29.0
11-15 Years	15	15.0
16-20 Years	8	8.0
21-25 Years	9	9.0
25-30 Years	6	6.0

Thirty-three biology teachers representing (33%) have been teaching biology for two to five years; twenty-nine of them (29%) have been teaching biology for six to ten years; fifteen of them (15%) have been teaching biology for eleven to fifteen years; eight of them (8%) have been teaching biology for sixteen to twenty years; nine of them (9%) have been teaching biology for twenty-one to twenty-five years ;whilst only six of them (6%) have been teaching biology for twenty-five to thirty years in their respective schools.

4.1.1 Information on remote learning

The number of participants that embarked on remote learning is shown in figure 4.2.



From figure 4.2, a significant large proportion of teachers (84, 84%) adopted remote teaching during Covid-19. However, few teachers (16, 16%) reported not adopting remote teaching during covid-19 pandemic.

4.1.2 Online learning technology used

Figure 4.3 represents the online learning technology used during the Covid-19 pandemic in Senior High Schools.

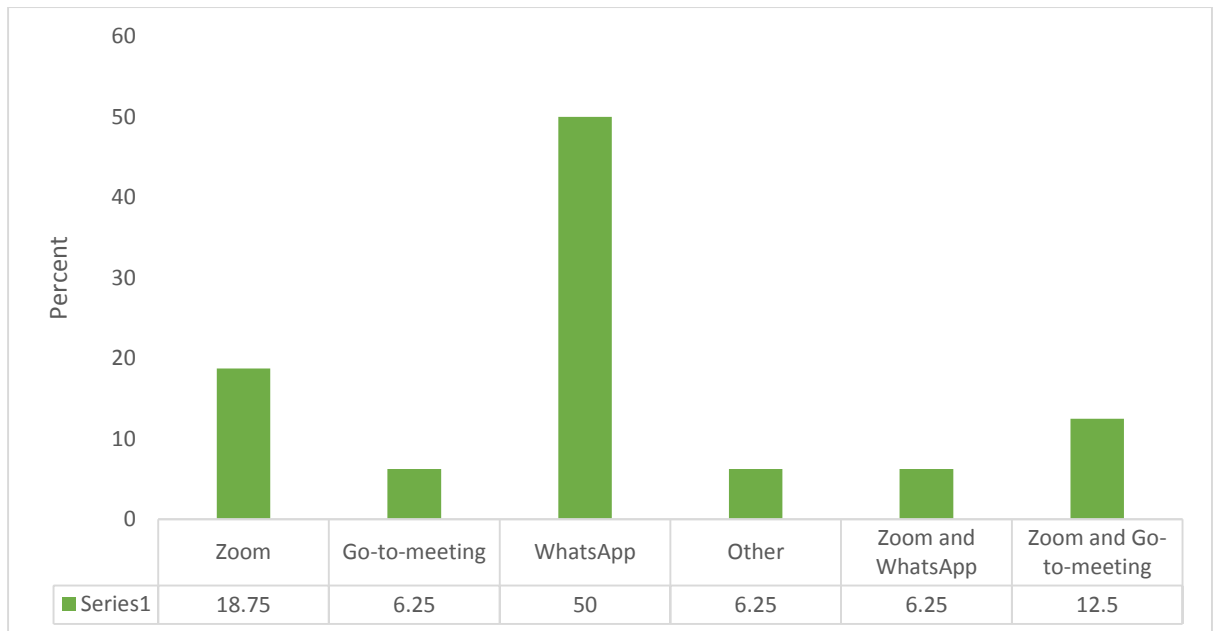


Fig 4.3: Online learning technology used

The results indicated that 18.8% of the respondents used zoom as online learning technology(figure 4.3), 6.3% of the participants used Go-to- meeting during the Covid-19 pandemic(figure 4.3), 50% of the respondents used WhatsApp as online learning technology during the pandemic(figure 4.3), only one of the respondents (6.3%) used both zoom and WhatsApp as learning technologies during the Covid-19 pandemic(figure 4.3), and two of them (12.5%) used zoom and Go-to-meeting as online learning technologies. Therefore, the highest used online learning technologies by the respondents was WhatsApp during the Covid-19 pandemic.

Table 4.4: Proficiency in virtual technology

Variable		N	%
Have you heard about virtual learning?	Yes	90	90.0
	No	10	10.0
Does your school use virtual learning?	Yes	14	14.0
	No	86	86.0
Have you ever used virtual technology in your teaching?	Yes	35	35.0
	No	65	65.0
Which virtual learning technology did you use?	Zoom	18	52.9
	Facebook	1	2.9
	WhatsApp	13	38.2
	Video recording	2	5.9
Confidence in using virtual teaching platform	Very confident	9	9.0
	Confident	45	45.0
	Neutral	30	30.0
	Not confident	13	13.0
	Not confident at all	3	3.0
Confidence in integrating digital technology in teaching	Very confident	8	8.0
	Confident	51	51.0
	Neutral	25	25.0
	Not confident	13	13.0
	Not confident at all	3	3.0

The first variable in table 4.4 asked the respondents whether they have heard about virtual learning and the results showed that ninety out of the total respondents (90%) said they had heard about online learning whilst ten (10%) said they have not heard about virtual learning.

Participants were also asked to indicate whether their schools used virtual learning during the Covid-19 pandemic and the findings from the data indicated that 14 out of the total respondents representing 14% said their schools used virtual learning technology during the Covid19 pandemic whilst 86 of them representing 86% said their schools did not use virtual learning during the Covid-19 pandemic.

Respondents were then asked whether they had used virtual learning in their teachings and the findings from the data showed that 35 out of the total respondents representing 35% said they have indeed used virtual learning in their lesson delivery whilst 65 of the participants said they have not used virtual learning in their teachings. Therefore, majority of the respondents did not offer virtual learning during Covid-19 pandemic.

The 35% of the respondents who said they offered virtual learning during the Covid-19 pandemic were then asked to indicate which virtual learning technology they used during the Covid-19 pandemic. And 18 of them representing 52.9% said they used zoom as the main virtual learning technology. Only one out of the 35 (2.9%) said he or she used Facebook as the main virtual learning technology whilst thirteen out of the 35, (38.2%) said they used WhatsApp as the main virtual learning technology and finally only two of them (5.9%) said they used video recording as the main virtual tool for instruction during the pandemic.

The respondents were also asked to indicate their confidence in using virtual learning as a teaching platform and the outcome of the study showed that nine of the respondents (9%) said they are very confident in using virtual technology as a teaching platform. Moreso, forty-five of them (45%) said they are confident in using virtual learning as a teaching platform. However, thirty of them (30%) remained neutral to whether they are confident in using virtual learning as a teaching platform. And a further thirteen of them (13%) said they are not confident in using virtual technology as a teaching platform whilst only three of them (3%) said they are not confident at all in using virtual technology as a teaching platform. Therefore, it can be concluded that from this outcome that majority of the biology teachers are very confident in using virtual learning as a teaching platform in senior high schools.

Finally, respondents were also asked to indicate how confident they are in integrating digital technology in their teaching and the findings from the data indicated that eight of them (8%) said they are very confident to integrate their biology lessons with digital technology. Besides, fifty-one of them (51%) said they are confident in integrating digital technology in their biology teaching but twenty-five of them (25%) remained neutral to whether they are able to integrate digital technology in their biology teachings. Thirteen of them (13%) said they are not confident in integrating digital technology in their biology teaching whilst three of them (3%) said they are not confident at all in integrating technology in their biology teaching. Therefore, majority of the respondents based on the findings are very confident in integrating digital technology in their lesson's delivery.



Table 4.5: Teaching methods, class management and assessment techniques used during covid-19

Variable	N	%
1. Employed teaching method		
Lecture	58	58.0
Demonstration	6	6.0
Discussion	28	28.0
Activity method	8	8.0
2. Were practical activities carried out?		
Yes	58	58.0
No	42	42.0
3. How often were practical lessons conducted?		
Very often	6	6.0
Often	40	40.0
Rarely	41	41.0
Not at all	13	13.0
4. Was class management effective?		
Yes	64	64.0
No	36	36.0
5. Was there tension during instructional periods		
Yes	45	45.0
No	55	55.0
6. Were digital technology employed during assessment?		
Yes	25	25.0
No	75	75.0
7. Which digital technology was employed?		
Google form	21	91.3
Socrative	2	8.7

4.1.3 Outcome on the teaching method employed during the Covid-19 pandemic

The results showed that fifty-eight (58%) said they used lecture method during the pandemic. Moreover, twenty-eight of them (28%) said they employed discussion method as a method of lesson delivery during the Covid-19 pandemic. However, eight of them (8%) and six of them (6%) said they used activity method and demonstration method respectively as the main methods of instruction during the Covid-19 pandemic. It can be therefore, concluded from the data analysis that majority of the respondents used lecture method to deliver their biology lessons during the Covid-19 pandemic.

Participants were also asked whether they were able to conduct practical lessons during the Covid-19 pandemic and the findings from the study showed that fifty-eight out of the total respondents (58%) said they were able to conduct practical lessons during the Covid-19 pandemic whilst forty-two of them (42%) said they did not conduct practical lessons during the Covid-19 pandemic. Therefore, it can be concluded from the data that many of the respondents that's biology teachers conducted practical lessons during the Covid-19 pandemic.

Respondents were also asked to indicate how often they conducted practical lessons during the Covid-19 pandemic and the outcome of the data indicated that six out of the total respondents (6%) said they conducted practical lesson often. In addition, forty of them (40%) also said they often conducted practical lesson during the Covid-19 whilst forty-one of them (41%) said they rarely conducted practical lesson during the Covid-19 pandemic and finally thirteen of them (13%) said they did not conduct practical lesson at all during the Covid-19 pandemic. It can be therefore, concluded that majority of the biology teachers did not conduct practical lessons in biology during the Covid-19 pandemic.

Respondents were further asked to indicate whether digital technology was employed as a means of assessing students' performance during the Covid-19 pandemic and the findings here also indicated that twenty-five of them (25%) said that they employed digital technology to assess biology students during the Covid-19 pandemic whilst seventy-five of them (75%) said they did not used digital technology to assess their students during the Covid-19 pandemic. Conclusively, based on the outcome of the data showed that many of the biology teachers did not employ digital technology to assess their students during the Covid-19 pandemic.

Moreover, respondents who answered they used digital technology to conduct assessment during the Covid-19 pandemic were further asked to indicate which digital technology tool they employed to conduct their assessment and twenty-one out of twenty-five (91.3%) said they used digital technology to assess their students said they specifically used Google form whilst two of (8.7%) said they employed Socrative as the main digital assessment tool.

The findings from the study on whether class management was effective during the Covid-19 pandemic indicated that sixty-four out the total respondents (64%) said they were able to manage class effectively during the Covid-19 whilst thirty-six of them (36%) said they were not able to manage their class effectively during the Covid-19 pandemic. Therefore, majority of the biology teachers were able to manage their class effectively during the Covid-19 pandemic.

The findings from the study on whether there was tension during instruction because students were asked to wear face masked in order to minimize the spread of the Covid-19 virus showed that forty-five of them (45%) said there was tension during instructional time for the fear of contracting coronavirus whilst fifty-five of them (55%) said there was no tension during the instructional period. It can be concluded based on this data that a slight majority were not tensed due to Covid-19 pandemic.

Distance learning solutions used for research

Figure 4.6 shows the distance learning solutions useful for research by biology teachers

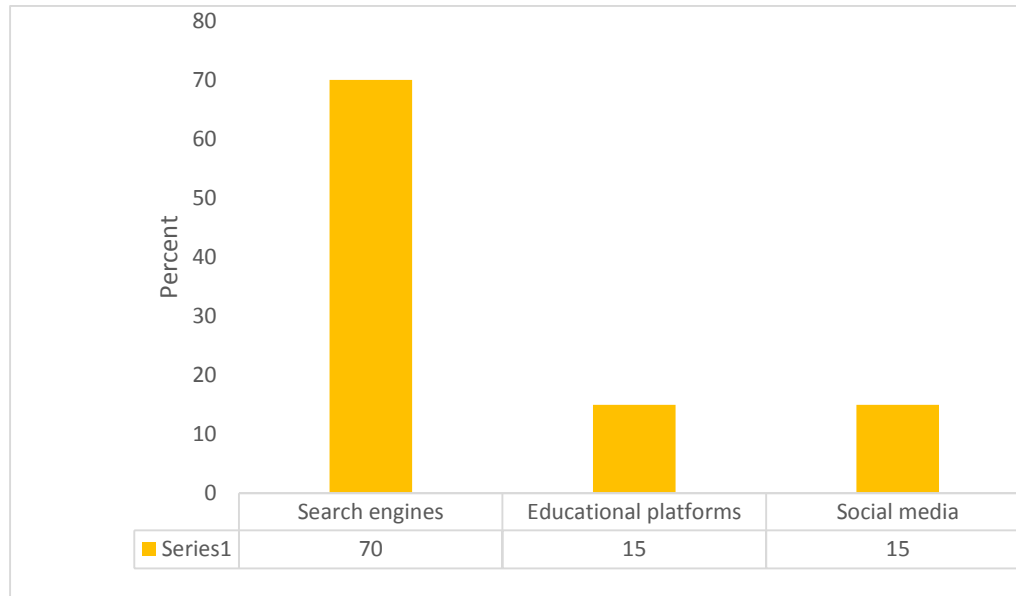


Fig 4.6: Distance learning solution used for research by biology teachers

The results showed that seventy of them (70%) used search engines for research during teaching whilst fifteen of them (15%) used social media as distance learning solution for research during teaching.

Distance learning Platforms

Figure 4.7 shows the distance learning platform useful for learning biology by biology teachers

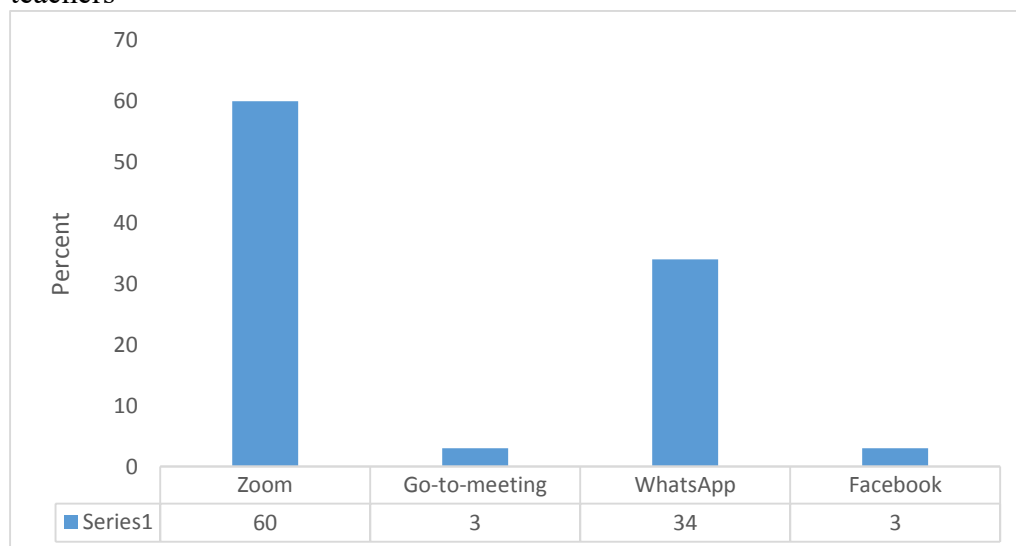


Fig 4.7: Distance learning platform useful for learning

The results showed that sixty of them (60%) said zoom is the most useful distance learning platform for biology teachers, thirty-four of them (34%) said WhatsApp is a useful distance learning platform whilst three of them (3%) said they used Go-to-meeting and Facebook as useful distance learning platforms respectively. It could be concluded based on this study that zoom is a powerful useful distance learning platform for biology teachers during a pandemic.



Obstacles faced by teaching and learning during covid-19

Figure 4.8 depicts obstacles face by biology teachers during Covid-19 pandemic.

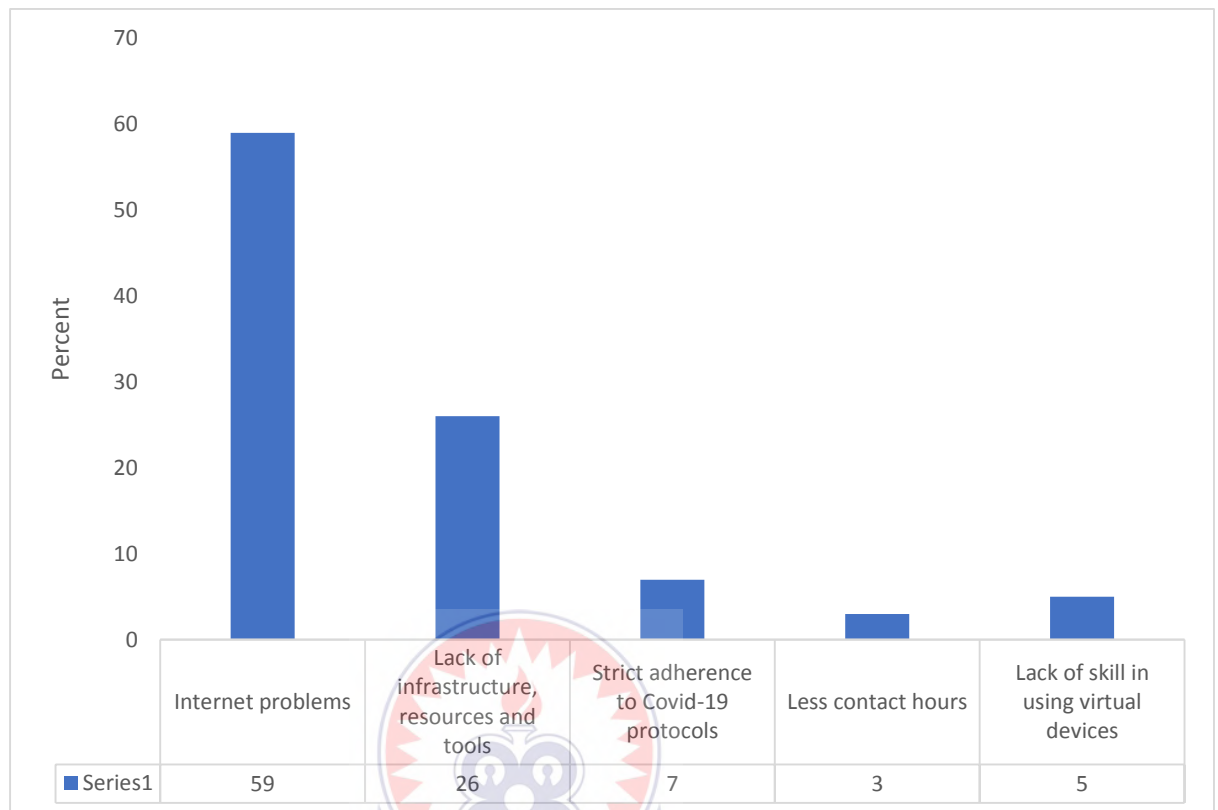


Fig. 4.8: Obstacles faced by biology teachers during Covid-19 pandemic

When the researcher asked the respondents about the hindrances faced by them during virtual instruction, the findings indicated that fifty-nine of them (59%) believed that internet connectivity is the main challenge confronting biology teachers during the Covid-19 pandemic, twenty-six of them (26%) said lack of infrastructure and tools are the main obstacles to virtual instruction during the Covid-19 pandemic, seven of them (7%) also said that strict adherence to Covid-19 protocols was an obstruction to virtual instruction during Covid-19 pandemic, three of them (3%) also believed that less contact hours was an obstacle to virtual instruction during the Covid-19 pandemic whilst five of them also opined that lack of skill in using virtual devices was a great obstruction facing virtual instruction during the Covid-19 pandemic. These findings are

in line with the literature according to Putri et al. (2020) who identified more challenges and obstacles such as restrictions in the choice of teaching methods that usually apply in regular face-to-face classes, less curriculum material coverage, lack of technological skills that hinder the potential for online learning, more time needed to develop e-content, longer screen times as a result of creating e-content as well as providing feedback on students work and higher internet bills. In other words, transforming to remote learning in such a short period of time was difficult especially, in developing countries, where technology advancements are not practiced much. Furthermore, literature proves that lack of IT infrastructure, insufficient IT knowledge of faculty members as well as poor internet services are major issues to remote learning (Rafiq et al., 2020). Though, Pakistani universities have internet and equipment facilities available on campuses yet it is difficult for them to provide student with these resources at their residences. Not only internet access, but also availability of broadband services is also difficult. According to Zahra et al. (2020) it was a difficult task to do online teaching and learning for both students and teachers because online classes in the time of Covid-19 were expensive. School closures for Covid-19 did not only increased pressures on students, teachers and parents especially those with limited digital skills, education and resources for continued education but also increased burden on parents not only to struggle to provide for their homes, but also to perform the supervision task of ensuring that their children learn from home. Purwanto et al (2020) revealed some of the challenges and obstacles experienced by students, teachers and parents in online learning. Challenges related to students are limited communication and outreach among students, higher challenges for students with special educational needs.

4.2. Research Question One

To what extent has Covid-19 pandemic impacted biology teaching strategies?

Table 4: Impact of covid-19 pandemic on biology teaching strategies.

Variable	SA	A	U	D	SD
1. Covid-19 affected biology teaching strategies	39.0	59.0	1.0	0.0	1.0
2. Practical activities were carried out	8.0	59.0	12.0	17.0	4.0
3. School curriculum should be reviewed to adapt to distance learning	32.0	62.0	4.0	2.0	0.0
4. Teachers were able to attend to learners' individual needs	8.0	62.0	15.0	11.0	4.0
5. Teachers were able to employ remote teaching	7.0	50.0	19.0	19.0	5.0
6. Biology teachers are experienced in online teaching	8.0	48.0	18.0	23.0	3.0
7. Digital assessment is becoming popular because Covid-19	14.0	75.0	9.0	2.0	0.0
8. Globalization and digital technology are rapidly changing education especially during covid-19	19.0	70.0	10.0	1.0	0.0
9. Lack of educational technologies is the biggest challenge to remote learning	34.0	64.0	2.0	0.0	0.0
10. Zoom is a useful distance learning technology for biology teacher	25.0	70.0	4.0	1.0	0.0
11. Digital technology helps teachers and learners to focus on critical thinking	19.0	72.0	8.0	1.0	0.0
12. Technology helps students' assessment to be integrated into learning process	18.0	78.0	4.0	0.0	0.0

The results showed that thirty-nine (39%) out the total respondents representing (39%) strongly agreed that Covid-19 pandemic affected biology teaching strategy (figure 4), fifty-nine of them (59%) agreed that Covid-19 pandemic affected biology teaching strategy, only one of them (1%) remained undecided and one of them (1%) strongly disagreed that Covid-19 affected biology teaching strategy. Therefore, it could be said that Covid-19 immensely affected biology teaching strategy. The results concurred with the findings by Brummet (2014), who asserted that school closures can either be reactive or proactive and that reactive closure of schools occur upon the discovery of Covid-19 cases among students, staff or parents and according to Muroga (2020), in

order to mitigate the effects that accompanied the closures of schools, educators and learners had to rely on use of technological tools and platforms to ensure continued education.

Furthermore, the responses from the researcher's question on school curriculum being reviewed to adapt to distance learning strategy indicated that thirty-two (32%) of them strongly agreed that senior high school curriculum should be reviewed to adapt to distance learning strategy (table 4), sixty-two (62%) of them also agreed that senior high school curriculum should be reviewed to adapt to distance learning strategy (table 4), whilst four (4%) of them remained undecided (table 4) and finally only one (1%) of them disagreed that senior high school curriculum should be reviewed to adapt to distance learning strategy (table 4). Therefore, it could be said that senior high schools' curriculum should be reviewed to adapt to distance learning strategy during a pandemic. The results concurred with the literature that schools were prematurely closed and as a consequence forced teachers to make a switch to a virtual environment, which requires them to integrate technology into their instructions. They have to change their approach in order to positively impact both the content elements and the students' perceptions. Biology teachers should be able to utilize technology to deliver biology curriculum, assess learners, direct them to research topics, and to use student-centered strategies integrated with technology (Ghaviferkr, et al., 2012).

The researcher wanted to explore the views of biology teachers on whether they were able to employ virtual learning during the Covid-19 pandemic.

The findings of the results showed that, seven out of the total respondents (7%) strongly agreed that biology teachers used remote teaching and learning during the Covid-19 pandemic (table 4), fifty of them (50%) agreed that remote teaching and learning was employed during the Covid-19 pandemic (table 4), nineteen of them (19%) remained

undecided and nineteen (19%) of them disagreed that remote teaching was employed during the Covid-19 pandemic (table 4) and finally five of them (5%) said they strongly disagreed that remote teaching was used during the Covid-19 pandemic. According to (Windhiyana, 2020), online learning is a form of learning that is implemented by utilizing an internet connection so that communication between educators and students is established without physical contact. According to (Saputro, 2020) online learning must remain oriented to the principles of learning outcomes and still pay attention to the accessibility abilities of students and these findings are completely incongruent with the literature according to Yildirim & Sensoys (2018) who studied the impacts of science teaching enriched with technological applications on the science course achievement levels. It has been determined that science teaching enriched by technical applications would have meaningful effect on the increase of the science course achievements level of the students and the permanence of this achievement. It also showed a significant rise in the science course achievement scores. Thus, using technology in learning environments logically and strategically with the right teaching methods will ease and enhance science learning (Oktay, 2013). This approach allows teachers to present the content in various ways, using text and multimedia and offered numerous chances for students to interact with the course content (DiPietro, 2010). The importance placed on relationship building and being able to understand students well enough to provide individualized instruction and a safe course environment means that teachers must be adept with virtual communication technologies. Regarding the current circumstances, Sintema (2020) has suggested that teachers have to step up their preparedness in containing the negative effects of this epidemic by bringing in teaching modes and strategies aimed at ensuring that students in examination classes are adequately prepared for the examinations And these results

are in congruent with the literature according to Kennedy & Archambault (2012) who found out that many teachers felt that strategies used in their face-to-face classrooms would not make sense in the online environment. Therefore, they have to change their approaches to teaching and their beliefs about teaching and learning which means switching from giving knowledge to guiding knowledge, in order to provide students with what they need as they needed it.

The researcher wanted to explore the views of biology teachers on whether they are experienced in online teaching during the Covid-19 pandemic and the findings from the study showed that eight of them (8%) strongly agreed that they are experienced in online teaching and learning (table 4), forty-eight of them (48%) agreed they are experienced in using virtual learning as a teaching strategy (table 4), eighteen of them (18%) remained undecided and twenty-three of them (23%) disagreed that they are experienced in online learning and finally 3 of them representing 3% said they strongly disagreed that they are experienced in online teaching and learning. It can be concluded without a doubt that majority of the biology teachers are experienced in online teaching and learning which is a fertile ground for remote teaching and learning in senior high schools.

The findings from the study that digital assessment is becoming popular because of Covid-19 pandemic showed that fourteen 14 of them (14%) strongly agreed that digital assessment is becoming popular because of the Covid-19 pandemic (table 4), seventy-five of them (75%) agreed that digital assessment is becoming popular because of Covid-19 pandemic (table 4), nine of them (9%) remained undecided and finally two of them (2%) disagreed to the fact digital assessment is becoming popular because of Covid-19 pandemic (table 4).The outcome of this findings indicated that digital assessment is becoming more popular because of Covid-19 pandemic. Technology can

be used in teaching and learning activities, which can be said to be a change from conventional to modern. The presence of technology has many positive effects on learning as the internet has been integrated into a tool used to complement learning activities as well as a means of conducting valid assessment of students' performances.

The researcher wanted to find out about the extent to which globalization and digital technology are rapidly changing education especially during Covid-19 and the results from the findings indicated that nineteen out of the total respondents (19%) strongly believed or agreed that globalization and digital technology are rapidly changing education during a pandemic (table 4), seventy of them (70%) agreed that globalization and digital technology are rapidly changing the world of education especially in times of a pandemic (table 4), whilst ten of them 10% remained undecided and finally only one of them (1%) disagreed that globalization and technology are rapidly changing education during Covid-19 pandemic (table 4). These responses are in line with the literature that opined that teaching and learning biology supported by information and communication technologies would offer an alternative to the solutions used in the traditional lecture-based approach. Learner-centered approaches to technology-enabled learning can empower learners and leverage good learning experiences that would not otherwise have been possible (Dumont, Istance, & Benavides, 2010).

The findings on whether biology teachers were able to attend to the individual needs of the learners during the Covid-19 pandemic indicated that eight out of the total respondents (8%) strongly agreed to the fact that individual needs of learners were attended to during the Covid-19 pandemic (table 4), sixty-two of them (62%) also agreed to the fact that teachers were able to attend the individual needs of the learners (table 4), fifteen of them (15%) remained undecided whilst eleven of them also (11%) disagreed that biology teachers were able to attend to individual needs of the learners

and finally five of them (5%) strongly disagreed that biology teachers were able to attend to the individual needs of the learners. It could be concluded from this data that majority of the biology teachers were able to attend to the individual needs of the learners during the teaching and learning process.

The findings from the question whether lack of educational technologies the biggest problem to remote teaching and learning in this country showed that thirty-four (34%) of the total respondents strongly agreed that lack of educational technologies is the biggest challenge confronting remote teaching and learning (table 4), sixty-four of them (64%) also agreed to fact that lack of educational technologies is the biggest challenge facing remote teaching and learning in this nation (table 4), whilst only two of them (2%) remained undecided and finally none of the respondents neither disagreed nor strongly disagreed to the fact that lack of educational technologies is the biggest challenge facing remote teaching and learning in this country (table 4). Therefore, it could be concluded from this data that lack of educational technologies to be employed for effective remote teaching and learning to be carried out is the major challenge confronting online teaching and learning. These findings are in line with the literature according to Putri et al, (2020) who identified more challenges and obstacles such as restrictions in the choice of teaching methods that usually apply in regular face-to-face classes, less curriculum material coverage, lack of technological skills that hinder the potential for online learning, more time needed to develop e-content, longer screen times as a result of creating e-content as well as providing feedback on students work and higher internet bills. In other words, transforming to remote learning in such a short period of time was difficult especially, in developing countries, where technology advancements are not practiced much. Furthermore, literature proves that lack of IT infrastructure, insufficient IT knowledge of faculty members as well as poor internet

services are major issues to remote learning (Rafiq et al., 2020). Though, Pakistani universities have internet and equipment facilities available on campuses yet it is difficult for them to provide student with these resources at their residences. Not only internet access, but also availability of broadband services is also difficult. According to Zahra et al. (2020) it was a difficult task to do online teaching and learning for both students and teachers because online classes in the time of Covid-19 were expensive.

The findings from the study on zoom being a useful online learning technology indicated that 25 out of the total respondents representing 25% strongly agreed that zoom is a useful online learning technology, seventy of them (70%) also agreed to the fact zoom is a useful distance learning technology during a pandemic (table 4), four of them (4%) also remained undecided whilst only one of them (1%) disagreed that zoom is a useful distance learning technology during a pandemic (table 4). It could therefore, be concluded that zoom is a useful remote learning technology during a pandemic in senior high schools. The result is in congruent with the literature according to Mulenga & Marbán (2020) who explored how prospective teachers engage in online learning activities during the Covid-19 pandemic and the study proposed a comprehensive and advanced pedagogic design to render lessons through virtual classrooms during and beyond the Covid-19 age. Due to the Covid-19 crisis, researchers and educators around the world are trying to find possible alternatives that can work for students to have a paradigm shift from the face-to-face modes of learning to online education. ICT enhanced learning is student-directed and diagnostic. Unlike static, text or print-based educational technologies, ICT enhanced learning recognizes that there are many different learning pathways and many different articulations of knowledge. ICTs allow learners to explore and discover rather than teacher centered approach of merely 'listen and remember'.

The findings from the question digital technology helps teachers and learners to focus on critical thinking during learning process indicated that 19 out of the total respondents representing 19% strongly agreed to the fact that digital technology assists both teachers and learners to think critically during instruction, seventy-two of them (72%) also agreed that digital technology helps teachers and learners to think critically during teaching and learning (table 4), whilst eight of them also (8%) remained undecided whether digital technology helps teachers and learners to focus on critical thinking during instruction (table 4). It could be concluded from this data that digital technology is a useful tool that equips teachers and learners with the opportunity to think critically. And this is in line with Berge (2008) who stated categorically that learning approaches using contemporary ICTs provide many opportunities for constructivist learning and support for resource based, student centered settings, critical thinking and by enabling learning to be related to context and to practice (Barron, 2005). Teachers could make their lecture more attractive and livelier by using multi-media which would enable students to capture the lessons taught them easily, think critically and also retained them for a longer span (Barron, 2005).

The findings from the study technology helps students assessment to be integrated into the learning process indicated that eighteen out of them (18%) strongly agreed that technology helps students assessment to be incorporated into the learning process (table 4), seventy-eight of them (78%) also agreed that technology helps students assessment to be integrated into the teaching and process (table 4), whilst four of them (4%) remained undecided as to whether digital technology helps learners assessment to integrated into teaching and learning process and finally none of the respondents

disagreed to the fact that digital technology helps students assessment to be integrated into the teaching and learning process (table 4).

4.3. Research Question two

Which teaching strategies could be adopted to teach biology during a pandemic?

Table 5: Teaching strategies that could be adopted during pandemic

	SA	A	U	D	SD
1. Biology teachers should use project-based learning technique	40.0	53.0	7.0	0.0	0.0
2. Remote teaching strategy should be employed during pandemic	25.0	68.0	5.0	2.0	0.0
3. Biology teachers should employ inquiry-based learning strategy	29.0	64.0	5.0	2.0	0.0
4. Teachers should employ lecture method of teaching	14.0	58.0	16.0	10.0	2.0
5. Teachers should use discussion method to teach during pandemic	19.0	74.0	6.0	1.0	0.0

SA=Strongly agree; A= Agree; U= Undecided; D= Disagree; SD= Strongly disagree

The results showed that forty out the total respondents (40%) strongly agreed to the fact that project-based learning strategy should be employed by biology teachers during a pandemic to deliver their instructions (table 5), fifty-three of them (53%) also agreed that project-based should be used to deliver lessons during a pandemic like the Covid-19 (table 5) whilst seven of them (7%) remained undecided but none of them disagreed or strongly disagreed (table 5). Therefore, biology teachers want project-based learning strategy to be employed by biology teachers during a pandemic. These responses are in line with the literature where scholars (Jonassen, et al., 2003) opined that constructivist approach teaching method would allow learners to construct their own knowledge as they are actively involved in the process of meaning and knowledge construction as opposed to passively receiving information. The utilization of constructivism in

educational settings has been shown to promote higher-order thinking skills such as problem-solving and critical thinking (Lu, 2007).

The researcher wanted to explore the views of biology teachers on whether remote teaching strategy could be employed by biology teachers during a pandemic. The findings from the study indicated that twenty-five out of the total respondents (25%) strongly agreed that remote teaching strategy should be used to teach biology in senior high schools during a pandemic (table 5), sixty-eight of them (68%) also agreed to the fact that remote teaching strategy should be employed to teach biology in senior high schools (table 5), five of them (5%) remained undecided but two out of them (2%) disagreed to the fact that remote teaching strategy should be used to teach biology in senior high schools. These findings are totally incongruent with Wheatley (2014) who asserted that organizational change occurs through a change in meaning in a symbolic framework. When the status quo is disturbed, the individual organization will be encouraged to change its operation mode. In organizational theory, the symbolic framework describes the university as a culture (Bolman & Deal, 2013). To create university change using a symbolic framework, lecturers must undergo a cultural change that causes face-to-face learning to be abandoned as a "ritual" of the past for something more beneficial to current university realities, namely online learning. Universities started moving from traditional face-to-face education to remote education from March, 2020 by providing students with course materials and recorded lectures which were sent through emails or uploaded on associated software platforms. This helped many universities to avoid compromising education in a pandemic situation (The News, 2020). And this could be adopted in the various Senior High Schools as a means to sustain teaching and learning in the midst of a pandemic.

On whether inquiry-based learning strategy should be employed by biology teachers during a pandemic; twenty-nine (29%) of them strongly agreed that inquiry-based learning strategy should be used by biology teachers during a pandemic (table 5), sixty-four of them (64%) also agreed that inquiry-based learning approach should be employed to teach biology in senior high schools during a pandemic (table 5), but five of them (5%) remained undecided and two of them (2%) disagreed to the motion that inquiry-based learning strategy should be used to teach biology in senior high schools (table 5). It could be concluded from this study that majority of the respondents agreed vehemently that enquiry-based teaching strategy is a good method of instructing biology students during a pandemic like the Covid-19. And these responses are in line with the literature where scholar (Bonk, 2009) opined that in biology education, selected teaching methods should support learning biology, learning to do biological science and learning about biological science. Several biological topics require approaches promoting experimental problem-solving and process-based skills. The focus is on science investigation processes and the goal is to reach valuable learning results and students therefore, need crucial science content knowledge as well as autonomous learning. Many biology teachers will need to reconsider teacher-centered pedagogies and apply more effective student-centered learning methods (Bonk, 2009). Recently reformers of the teaching of science called for new approaches in which students contribute to the growth of their own biological knowledge as an attempt to shift to student-centered learning in which students could formulate and solve problems about biological systems, Quentin (2014). In student-centered teaching the teacher acts as a facilitator, creating the learning conditions in which students actively engage in experiments, interpret and explain data and negotiate understandings of the findings

with their peers, Arkorful, 2015). For students, learning science is an active and constructive mechanism, involving inquiry and hands-on activities (Ronoh, 2014).

The data on whether lecture learning strategy should be used by biology teachers during a pandemic indicated that fourteen of the respondents (14%) strongly agreed that lecture method should be employed by the biology teacher during a pandemic (table 5) and fifty-eight of them (58%) agreed that lecture method could be applied to instruct senior high schools children (table 5), sixteen of them (16%) remained undecided and finally ten of them (10%) disagreed to the fact that lecture method should be used by biology teachers to teach in senior high schools (table 5) but only two of them strongly disagreed that lecture method should be employed by biology teachers to deliver their biology concepts in senior high schools.

The findings on the study as to whether discussion method should be employed by biology teachers to deliver their lessons indicated that nineteen out of the total respondents (19%) strongly agreed to the fact that discussion method should be employed by biology teachers to instruct students during a pandemic (table 5), seventy-four of them (74%) also agreed that discussion is a good teaching strategy that should be employed to teach biology in senior high schools during a pandemic (table 5) whilst six of them (6%) disagreed that discussion method should be used by biology teachers to deliver their lessons in senior high schools (table 5) and none of them strongly disagreed that discussion method is a good teaching strategy in senior high schools during a pandemic. It could be concluded from the findings that discussion should be adopted as a method of instruction during a pandemic in senior high schools in Ghana and this is in congruent with the literature according to Mayer (2003) that knowledge

is created through experiences and interactions that occur within one's environment as knowledge is a process, not a product and occurs continuously.

4.4. Research Question three

How could the teaching strategies be used effectively and efficiently during a pandemic?

Table 6: How teaching strategies being used effectively and efficiently during a pandemic

Variable	SA	A	U	D	SD
1. Government should provide free laptops to Senior High School students	24.0	68.0	5.0	3.0	0.0
2. Students should be given the topic for discussion to research in advance	19.0	78.0	2.0	1.0	0.0
3. Practical lessons in biology can be taught via zoom	14.0	68.0	10.0	6.0	2.0
4. Biology teachers should use digital technology to assess students	8.0	58.0	22.0	9.0	3.0
5. Digital assessment track students' progress in real time	11.0	79.0	7.0	2.0	1.0
6. Biology teachers should use incentive constructive feedback to encourage students learning	19.0	74.0	7.0	0.0	0.0
7. Biology teachers should always distribute study materials among students a week before the lesson	15.0	74.0	5.0	6.0	0.0

SA=Strongly agree; A= Agree; U= Undecided; D= Disagree; SD= Strongly disagree

The findings from the study showed that nineteen of them (19%) strongly agreed that the topics for study or discussion should be given to the students in advanced to research on in order to have fair knowledge on the topic before the day of instruction (table 6), seventy-eight of them (78%) agreed that the topic for the lesson should be given to students in advance before the day of instruction (table 6), but two of them (2%) remained undecided and one of them (1%) disagreed that the topic for discussion should be given to learners in advance before the actual day of the lesson (table 6). These

findings are totally in congruent with literature according to (Schmidt, et al., 2007) who believed that Problem-based learning begins with an educator presenting a series of carefully constructed problems or issues to small groups of students and the problems or issues typically pertain to phenomena or events to which students possess limited prior knowledge. The first component of problem-based learning is to discuss prior knowledge and ask questions related to the specific problems or issues. Within the educational setting, problem-based learning has enabled students to actively construct individual understandings of a topic using both prior and newly acquired knowledge. Moreover, students also develop self-directed and group learning skills which ultimately facilitates the comprehension of the problems or issues (Özmen, 2004).

The findings from the study on biology teachers using constructive feedback to encourage students learning during a pandemic indicate that seventy-four of them (74%) agreed that incentive constructive feedback should be used to encourage students learning during a pandemic (table 6) and nineteen of them (19%) also strongly agreed that incentive constructive feedback should be used to encourage students learning during a pandemic like the Covid-19 (table 6), seven of them (7%) remained undecided, but none of the respondents disagreed that incentive constructive feedback should be used to encourage students learning (table 6). Therefore, biology teachers want incentives constructive feedback to be used to encourage students learning during a pandemic and these findings are in line with the literature that stated that teachers should devise different activities which can enhance students' learning skills in online classes (Bao, 2020). Moreover, teachers should also ask challenging questions from students during online classes as these practices will help instill better learning abilities in students and ensure that they are more focused in class (Smith, et al., 2004). Greater interactivity in online course will enhance the overall online class success rate.

Literature depicts that more student and teacher discussion can result in higher interactivity (Townsend et al., 2002). Besides these, getting feedback from students about these online classes enhance the capacity of online learning.

The findings from the study on whether biology teachers should always distribute study materials among students a week before the lesson indicated that fifteen out of the total respondents (15%) strongly agreed to the fact that study materials should be distributed to the learners a week before the lesson (table 6), seventy-four of them (74%) agreed to the fact that study materials should be distributed to learners a week before the lesson (table 6), whilst five of them remained undecided but six of them disagreed that study materials should be distributed to the learners a week before the lesson (table 6). These findings are totally in congruent with literature according to Marek, et al., (2000) who pointed out that students would assimilate the essence of the concept and as well as the learning activities when the materials for instruction are supplied by the teacher and the role of him or her is just to encourage students and give them some suggestions to maintain an appropriate level of knowledge construction. The teacher takes an active role in presenting the concept and students redefine, change, or invent mental structures to comprehend the concept.

The outcome of the study on biology teachers using digital technology to assess their students during a pandemic indicated that eight out of the respondents (8%) strongly agreed that digital assessment should be used to assess learners during a pandemic (table 6) and fifty-eight of them (58%) agreed that digital assessment should be used to assess learners during a pandemic (table 6), whilst twenty-two of them (22%) remained undecided but nine of them (9%) disagreed that digital assessment should be used to assess learners during a pandemic(table 6) whilst three of them (3%) strongly disagreed that digital assessment should be used to assess learners during a pandemic (table 6).

It could be concluded from this finding that digital technology could be used to assess students during a pandemic and this is in incongruent with Wood, 2004 who stated that learning process is different in digital media and the new generations are more interconnected and better informed. Due to positive impact of digital media, it is very easy to work as a group for project assignments by using social networking and so students' progress can be assessed by using digital assessment on different groups on different social networks like WhatsApp, twitter; Facebook and email to share input regarding to the assignments.

The outcome of the data showed that seventy-nine out of the respondents (79%) agreed that digital assessment track students' progress in real time (table 6), eleven of them (11%) strongly agreed that digital assessment can be used to track students' progress in real time (table 6) but seven of them (7%) remained undecided (table 6), two of them (2%) disagreed that digital assessment can be used to track students' progress (table 6), one of them (1%) strongly disagreed that digital assessment can be used to track students' progress (table 6). It could be concluded from the findings that digital assessment could be used to track students' progress in real life and this is in line with the literature according to Barron (2005) who opined that teachers could make their lecture more attractive and livelier by using multi-media which would enable students to capture the lessons taught them easily, retained them for a longer span as well as to track their progress in real life. The presence of technology has many positive effects on learning as the internet has been integrated into a tool used to complement learning activities as well as a means of conducting valid assessment of students' performances.

The findings from the study on whether government should provide free laptops to senior high school students indicated that sixty-eight of the respondents (68%) agreed that the government should provide free laptops to senior high school learners (table

6), twenty-four of them (24%) strongly agreed that free laptops should be supplied to senior high school learners but five of them (5%) remained undecided (table 6), six of them (6%) disagreed that free laptops should be supplied to senior high school learners (table 6). It could be concluded from this finding that free laptops with computer-assisted software and effective digital learning materials and learning activities should be provided to students and teachers to sustain teaching and learning during a pandemic (table 6). And this is in line with the literature according to Putri, et al., (2020) stated that along with the times, a person can get information easily through new technologies that continue to develop. This technological development can be beneficial in the field of education for both teachers and students. From the students' perspective, science is a lesson that is boring and difficult and therefore, teaching activities should be shaped by using computer-assisted software and effective digital learning materials (Bayturan, 2011). In this context, it is imperative to strengthen the hardware infrastructure of the schools and the development of biology software to increase the importance of computer-assisted biology teaching every day.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter gives the summary of the findings of the study that emerged out of the intervention lessons. The chapter also contains conclusions derived from the findings of the study. It also made recommendations to biology teachers among others and suggestions for further studies.

5.1 Summary of findings

The following were the major findings that emerged from the study:

1. Covid-19 pandemic has changed the running of biology classrooms as biology teachers moved from traditional face-to-face education to remote education by providing students with course materials and recorded lectures which were sent through emails or uploaded on associated software platforms. School curriculum should therefore, be reviewed to adapt to distance learning technology in Senior High Schools so that education would not be disrupted during a pandemic. Teaching activities should be shaped by using computer-assisted software and effective digital learning materials (Bayturan, 2011). In this context, it is imperative to strengthen the hardware infrastructure of the schools and the development of biology software to increase the importance of computer-assisted biology teaching every day.
2. Remote teaching should be implemented to complement the weaknesses of face-to-face teaching. Online learning is defined as a teaching and learning activity that utilizes a network or internet connection so that communication is established between the teacher and students without involving physical

contact. Though remote learning technology cannot completely replace the classroom learning experience, yet it should be structured to have the features that allow it to better emulate classroom settings. TV and radio programs can be pre-recorded and made live, where interactive lessons are difficult. Digital technology such as the internet, personal computers, tablets and mobile phones may be more suitable for emulating classroom-like interactions. The teaching process should contain sufficient number of visual demonstrations (animations, videos), in order to make remote teaching an appropriate form of teaching for biology.

3. The results showed also that about 93% of the teachers agreed that Project-based learning as well as inquiry-based learning teaching strategies should be adopted by biology teachers for instruction during a pandemic. This is because these strategies would allow learners to construct their own knowledge as 21st century learners who would possess the needed problem-solving skills to address the numerous challenges confronting societies
4. It was found out that about 90% of the teachers agreed that topics and study materials should be given ahead of time to students. In view of that the topics and study materials for every lesson should be given to the students in advance before the actual day of instruction and biology teachers should also use constructive feedback to encourage students learning during a pandemic as this will empower them to construct their own knowledge. In addition, biology teachers should also use digital technologies to assess students' progress during a pandemic as majority of the respondents did not use digital assessment to assess their students during the Covid-19 pandemic. The few however, that

adopted digital technology to assess their students used google form as the main tool of assessment.

5. Lack of educational technology was one of the major challenges to virtual learning in Senior High Schools in Ghana during the Covid-19. Many second cycle institutions in the country do not have access to modern computer laboratories and the few schools which have computer laboratories have their facilities outmoded. The government of Ghana recently established WIFI in some of the senior high schools but unfortunately this is not covering a wide area so cannot be used by teachers who are residing on campus for instruction. Therefore, lack of internet connectivity is also a major challenge to virtual learning in Ghana. Relatively few schools engaged in distance learning modalities and this can largely be attributed to the digital divide, with majority having limited access to basic household services such as electricity; a lack of technological infrastructure; and low levels of digital literacy among students, parents, and teachers. In technical and vocational education systems, vulnerabilities include low levels of digitalization and long-standing structural weaknesses, which have been brought to light by the crisis.
6. Globalization and digital technology are rapidly changing education especially during a pandemic. Therefore, government officials and NGOs should help the entire second cycle educational institutes to establish online classes system in the country with proper provision of relevant digital solutions with relevant content, adequate instructional models, effective teaching practices, and a supportive learning environment. The government and non-governmental organizations should provide free laptops to every Senior High School child.

5.2 Conclusions

Covid-19 pandemic contributed to the closure of schools throughout the country and the world at large. Teachers' physical health was also put at risk when they were required to provide face-to-face education for all children of school going age especially students in second cycle institution in Ghana. With the combined effect of the pandemic's worldwide economic impact and the school closures, the learning crisis could generate into a generational catastrophe if not properly addressed. Therefore, ensuring learning continuity during the time of school closures became a priority for governments in all over the world. The restrictions and measures established to prevent the corona virus from spreading led to changes in the education system in which online teaching became a primary means of education. Such a transition to online teaching has created various challenges not only for students but also for teachers who had to adjust the content and curriculum with respect to the education and activity of students. Teaching strategies in science is a key factor to all stakeholders in the education sector. Consequently, several studies have been conducted to determine ways to improve teaching strategy in science especially biology. From the onset of the pandemic, teachers were immediately tasked with implementing distance learning modalities, often without sufficient guidance, training, or resources. In many contexts, teacher professional development has been moved online or been disseminated via telephone and video applications, but marginalized teachers may have missed out on such support. Web-based class meetings and messaging applications have become useful tools as new ways of teaching.

Technology-based teaching and learning which involve using ICT tools and equipment will help create an active learning environment that is more interesting and effective for both teachers and students. Therefore, technology-based teaching and learning

should be integrated in second cycle institutions and if the process of integration in schools can take place appropriately from the very beginning and continuous maintenances are sufficiently provided, then technology-based integration in schools will result in a huge success and will be beneficial to both teachers and students. The use of technology-based especially in teaching and learning should be practicalized and therefore, teachers should be given the opportunity to learn and explore it, face the “trial-and error” phase so that they would be completely comfortable with its usage and be able to make use of it for teaching and learning. Therefore, the integration of ICT in classroom needs serious consideration in order to increase the competency of the country’s education system. In order to enhance the use of technology-based in classroom, the government needs to improve and change the teachers’ belief about the integration of technology in classroom. Biology teachers should be empowered with good skills and knowledge in using technology to improve their teaching methods and approaches in order to promote effective learning as well as meeting the demand of the 21st century teacher especially during a pandemic. The standards for science teaching indicate that what students learn is influenced by the teaching methods and approaches, so teaching should be done to actively engage students, incorporate cooperative learning, and eliminate the rote memorization of facts. Inquiry-based teaching method as well as project-based learning strategy should be employed to teach biology during a pandemic. These approaches are student-centered learning models which shift instruction from teacher-centered and build learners competency to empower them to possess the requisite skills needed to address contemporary issues. Covid-19 pandemic has also called for the establishment of digital systems to assess students’ performances in the second cycle schools. Students’ progress can be monitored with the appropriate

digital assessment technology in order to identify learning gaps so that they can be remedied.

Finally, preventing the learning crisis from becoming a generational catastrophe should be a top priority for world leaders and the entire education community. This is the best way, not just to protect the rights of millions of learners, but to drive economic progress, sustainable development and lasting peace. The changes that are taking place due to the Covid-19 pandemic should be driven by advanced communication technology designed with the appropriate teaching and learning strategies which would allow teachers and students to learn wherever they are either at school or home.

5.3 Recommendations

Based on the findings of the study, the following recommendations are given:

1. There should be an opportunity to train biology teachers as well as in-service teachers in new methods of education delivery which will involve giving considerable attention to the use of technology to ensure learning continuity in the midst of a pandemic. That is, teacher should be properly developed with the right professionalism needed to ensure that they are delivering the content elements as 21st century qualified teachers,
2. The education ministry should strengthen dialogue with ministry of finance in a systematic and sustain way to maintain and, where possible, increase the share of the national budget for education. Governments should also strengthen systems of support for teachers, facilitators, and parents or caregivers in the successful and the safe use of technology for teaching and learning.

3. There should be provision of relevant digital solutions with relevant content, adequate instructional models, effective teaching practices, and a supportive learning environment. Therefore, government officials and non-governmental organizations (NGOs) should help the entire second cycle educational institutes by establishing online classes system in the country.
4. There should be the need to expand the definition of the right to education to include connectivity entitlement. Digital solutions needed to improve teaching and learning during a pandemic should be institutionalized to establish equity and inclusion at their centers, in order to ensure that all children may benefit from them. Teachers and learners need free and open-source of technologies for teaching and learning because quality education cannot be provided through content established outside of the pedagogical space and outside of human relationships between teachers and students and therefore, government should support open educational resources and open digital access.
5. There should be the need to remove barriers to connectivity. The Covid-19 pandemic has brought a deeper understanding of the digital divide and related equity gaps, which require urgent attention. Government and developmental partners should work together to remove technological barriers by investing in digital infrastructure and lowering connectivity costs. It will be necessary to ensure that teachers and children in every part of the country have better access to the internet, stronger parental support and greater availability of learning materials which will enable maximum benefit to all.

6. A national vision of science teaching and learning should be promoted to accentuate the need to restructure science education by making science classrooms across the country an active project-based and inquiry-based environments. Therefore, there should be a lot of research into project-based learning and inquiry-based teaching and learning to allow many teachers to use these non-traditional teaching approaches during pandemics.

5.4 Suggestion for further studies

The study was limited to only biology teachers in ten (10) Senior High Schools in the Cape Coast metropolis of the Central Region of Ghana. Therefore, the following suggestions are made for further studies:

1. A study can be conducted with a larger and more representative sample from other regional and district senior high schools to examine the impact of Covid-19 on the teaching of biology in senior high schools in Ghana. Besides, a further study can be carried out at different levels of education and subject areas to investigate the teaching strategies that can be adopted to teach Senior High School students during a pandemic.
2. A study should be carried out to examine the perceptions and knowledge of science teachers on the use of digital technology and the barriers that confront teachers in using technology in their daily online classrooms during a pandemic. A further study should be also carried out to determine how project-based learning and inquiry-based learning can be used to effectively and efficiently teach Senior High Schools students during a pandemic.

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APPENDICES

UNIVERSITY OF EDUCATION, WINNEBA
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF SCIENCE EDUCATION
BIOLOGY TEACHERS' QUESTIONNAIRE

This questionnaire is designed to solicit information on the **impact of Covid-19 on teaching strategies on biology in Senior High Schools in Cape Coast metropolis.**

Your responses will be treated confidentially and will be solely used for academic purposes. You are kindly requested to read through the items and respond to them as frankly and objectively as possible. Thank you.

SECTION A

DEMOGRAPHIC DATA

Please place a tick [] in the appropriate box.

1. Gender : Male[] Female[]

1. How long have you been teaching biology in your school?

2-5 years [] 6-10 years[] 11-15 years[] 16-20 years[]

21-25 years[] 26-30 years[]

SECTION B
TECHNOLOGY USED AND PRACTICES ADOPTED DURING
COVID-19; PROFICIENCY IN VIRTUAL TECHNOLOGY AND
TEACHING METHODS AND ASSESSMENT TECHNOLOGIES USED
DURING COVID-19.

1. In your school, what do you think is the biggest challenge with regard to using educational technology effectively during the COVID-19 crisis?
2. Did your institution offer remote teaching and learning during the Covid-19?
YES [] NO []
3. Were practical activities carried out during the Covid-19 pandemic?
YES [] NO []
4. How often were practical lessons conducted in the laboratory during the Covid-19?
Very often [] Often [] Rarely [] Not at all []
5. In your school, what did you consider to be the most significant obstacle facing learners during the COVID-19 pandemic?
6. Which distance learning solution do you think is most useful for senior high school biology learners during the Covid-19 crisis?
Zoom [] Go to meeting [] WhatsApp [] Facebook []
7. Which particular teaching method did you employ during the Covid-19?
Lecture method [] Demonstration method [] Activity method []
Discussion method []
8. Was class management effective during Covid-19 pandemic?
YES [] NO []
9. Were you able to attend to the individual needs of your students during the Covid-19 pandemic? YES [] NO []

10. Was assessment conducted often during the Covid-19 pandemic?
YES [] NO []
11. Was there tension during instructional periods because students were asked strictly to follow Covid-19 protocol? YES [] NO []
12. Which of these digital platforms do you use for your research and teachings?
- a. Search engines such as Google, Bing, Yahoo, Baidu, etc.
 - b. Educational platforms such as TedEx, Udemy, Coursera, Khan Academy, etc
 - c. Social media platforms such as YouTube, Facebook, twitter, LinkedIn, etc
 - d. Others.....
13. Have you ever heard about virtual learning? YES [] NO []
14. Does your school use virtual learning? YES [] NO []
15. Have you ever used virtual learning in your lesson delivery?
YES [] NO []
16. How confident are you in using virtual learning as a teaching platform?
- a. Very confident []
 - b. Confident []
 - c. Neutral []
 - d. Not confident []
 - e. Not confident at all []
17. How confident are you in integrating digital technology in your teaching?
- a. Very confident []
 - b. Confident []
 - c. Neutral []
 - d. Not confident []
 - e. Not confident at all []

SECTION C

To what extent did Covid-19 pandemic impact on biology teaching strategies in senior high.

Please place a tick [√] in the appropriate box.

Items	Responses				
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. Covid- 19 affected biology teaching strategies in senior high school.					
2. Practical activities were carried out during the Covid-19 pandemic.					
3. School curriculum in senior high schools should be reviewed to make it easier to adapt to distance learning.					
4. Teachers were able to attend to the individual needs of learners during the Covid-19 pandemic.					
5. Biology teachers were able to employ remote teaching during the Covid-19 pandemic.					
6. Many biology teachers had experienced with online / distance learning during the pandemic.					
7. Digital assessment is getting popular because of the Covid-19 pandemic.					
8. Globalization and digital technology are rapidly changing the world of education especially during a pandemic.					

SECTION D

What teaching strategies could be used to teach biology students during a pandemic?

Please place a tick [✓] in the appropriate box.

Items	Responses				
	Strongly Agree	Agree	Undecided	Disagree	Strongly disagree
1. Biology teachers should use problem-based learning technique during a pandemic in senior high schools.					
2. Remote teaching strategy should be employed to teach biology during a pandemic in senior high schools.					
3. Biology teachers should employ inquiry- based learning strategy during a pandemic in senior high school.					
4. Biology teachers should employ lecture method of teaching during a pandemic in senior high schools.					
5. Lack of educational technologies is the biggest challenge to remote learning in senior high schools.					
6. Zoom is a useful distance learning technology for senior high school biology teachers.					
7. Digital technology grants opportunity for teaching and learning to move their focus from content to critical thinking.					
8. Biology teachers should use discussion method to teach students online during a pandemic in senior high schools.					
9. Teaching and learning are becoming learner centered and technology provides an opportunity for students' assessment to be integrated into the learning process with corresponding adjustment.					

SECTION E

How could these teaching strategies be used effectively and efficiently during a pandemic?

Please place a tick [√] in the appropriate box.

Items	Responses				
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. Biology teachers should always distribute study materials among students a week before the lesson.					
2. Resources for learning should be observed by students and give their observations before the actual lesson.					
3. The government should provide free laptops for each senior high school students.					
4. Students should be given the topic for discussion to research in advance and provide their findings a week before the day of the lesson whilst the teacher provides guidance.					
5. Practical lessons in biology can be taught via the zoom in senior high schools.					
6. Biology teachers have been using digital technology such as google form, Socrative, Kahoot to assess their students.					
7. Digital assessment systems guide students through each examination, track their progress in real-time and provide access to any assistive tools they may need to complete their work					
8. Digital assessment technology can be used to assess students' learning.					
9. Biology teachers should use incentive constructive feedback to encourage students learning.					