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Exploring the Availability and Utilisation of Modern Resources for Teaching Life Sciences in Some Selected Schools in South Africa

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Abstract

Life sciences in South Africa cover a broad range of disciplines and have significant contributions in both academic and practical fields. This paper explores the availability and utilization of modern resources for teaching Life Sciences in some selected schools in South Africa. The study employs a transformative paradigm of qualitative research using a phenomenological case study design. Eight teachers were purposively selected and the data were analysed using a thematic approach. The findings revealed among others that without modern resources the teaching and learning of Life Sciences will be a mirage and teachers will find it difficult to disseminate the contents of the subject and achieving learning outcomes will not be possible. The study concludes that Life Sciences teachers need to employ the use of modern resources to meet the needs of the learners in the 21st century. It was recommended that the teacher should update their knowledge in the use of modern resources for teaching Life Sciences and resources should be used following the subject matter and the grade level of the learners.

Keywords: *Digital Learning, Educational Infrastructure, Internet, Life Sciences, Modern Resources.*

Introduction

For life science education in South Africa to be both effective and engaging, a range of resources are needed. Textbooks, lab apparatus, digital tools, field trip opportunities, and supplemental materials that support the curriculum are some examples of these resources (Mahambehlala, 2019). Textbooks and workbooks are two important teaching tools in South Africa for the life sciences. These authorised textbooks for grades 10 through 12 correspond with the National Curriculum Statement (NCS), and they also include workbooks and practice books with exercises, real-world applications, and practice exams to help students retain what they've learned (Mxenge & Bertram, 2023).

Other resources utilised in South African life science education include laboratory supplies and equipment, such as microscopes, which are necessary for examining cells, microbes, and tissues. Additionally, supplies such as chemicals and glassware for performing chemical reactions and experiments using preserved biological specimens for analysis and dissection. Among the resources for teaching life sciences are the models and charts that serve as visual aids to illustrate biological structures and processes (Kazeni, & Mkhwanazi, 2021).

The resources used to teach life science have undergone a paradigm shift as a result of COVID-19. These resources include digital technology and resources, educational software, and applications for interactive programmes that offer simulations and virtual labs. Websites, portals, and other online learning platforms provide videos, lessons, tests, and other content. The study of microscopic organisms and physiological processes is improved by digital microscopes and probes (Mahambehlala, 2019; Teo et al., 2021).

The unprecedented advent of COVID-19 put pressure on teachers and the education system to make use of Information Communication and Technologies (ICT) for virtual classrooms. This will foster the production of 21st-century students for the industrial revolution(Teo et al., 2021). There is a need for teachers and students to be technologically inclined and be better citizens who meet the test of time. In the teaching of Life Science and Science education, teachers are encouraged to move away from the pure use of traditional techniques to innovative pedagogies (Farion et al, 2019). 21st-century teachers need to

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embrace modern technology and ICT to creative digital learning environment and promote the construction of knowledge (Ojo & Adu, 2018; Magen-Nagar & Firstater, 2019).

Research evidence has shown that teachers who failed to embrace the use of virtual classrooms especially during COVID-19 went on early retirement because they were not relevant in the teaching industry (Adu et al., 2022; Ramnarain, Ncube, & Teo, 2023). Education technology tools are needed for the effective teaching of Life Science and in science classrooms to improve problem-solving and critical thinking skills. Despite the evidence, ICT has not been utilized as expected in science classrooms. According to Ramnarain, Ncube, and Teo, (2023), there are potential barriers to the use and integration of ICT in teaching and learning (Farjon et al, 2019). These barriers include inadequate provision of ICT resources, the use of ICT resources, the pedagogical beliefs of teachers and students and lack of skills in the use of gadgets (Nelson & Hawk, 2020).

Similarly, there are impediments to the use of ICT on the part of the students especially in Science Education, students' culture and attitude to the use of devices, lack of data, lack of readiness for change, students' inability to move to a better location where bandwidth is high. On the part of the government, lack of infrastructure especially electricity in some areas in South Africa and provision of ICT resources for the schools. (Juggernath & Govendor, 2020; Taimalu & Luik, 20019).

Teachers are said to be custodians of knowledge dissemination, therefore, their beliefs in the use of technology as a cognitive tool are very imperative. These beliefs have a lot of influence on the use of technology in classroom practice (Tondeur et al., 2017). Pedagogical beliefs can influence the decision to use ICT, lesson planning, and strategies for classroom management. Teachers' beliefs are context-bound and can affect the delivery of the curriculum contents (Ramnarain, Ncube, & Teo, 2023).

Research has shown that there is a significant relationship between teachers' pedagogical beliefs and ICT integration in teaching and learning Science (Magen-Nagar, & Firstater, 2019). Teachers' pedagogical beliefs are a factor that influences how teachers integrate ICT into their teaching (Ramnarain, Ncube, & Teo, 2023; Bozkurt, 2016). However, there are need for more empirical studies that will enhance credible evidence. Hence, this paper explores the availability and the use of modern resources for the teaching of Life Science.

South African white paper on e-learning since 2013 needs to be revamped especially the exposure of inequality in resources that COVID-19 brought, it was also articulated in 2013 that all primary and secondary school learners should be computer literate and ICT should be integrated into the curricula (Bozkurt, 2016; Bamath, 2021). The white paper emphasized that learners should learn about, learn with, and learn through ICT (Ramnarain, Ncube, & Teo, 2023; Bozkurt, 2016). Even, at this, effective integration of ICT in teaching and learning is still limited (Ojo & Adu, 2018; Padayachee, 2017). Researchers (Munje & Jita, 2020; Ramnarain, Ncube, & Teo, 2023) believe that some external factors such as Science teachers' beliefs and practices, and lack of research on the integration of ICT into teaching practice etc. should be eliminated before teachers can successfully use modern resources to teach Science Education (Emiere, 2021).

Among the contemporary teaching tools apart from ICT for teaching life sciences are projectors and smartboards for interactive classes and presentations. Teaching tools include interactive whiteboards that provide dynamic and interactive instruction, posters and diagrams that provide difficult biological concepts with visual aids, and flashcards and charts that are helpful for memorization and quick reference (Kazeni, & Mkhwanazi, 2021; Nelson & Hawk, 2020).

Field visits and outdoor education, such as going to parks and nature reserves, provide students with the opportunity to study ecosystems, biodiversity, and conservation activities in authentic environments. Additionally helpful for offering interactive activities and instructive exhibits are science centres and museums. Students can be escorted to zoos and botanical gardens, which provide a closer look at the plant and animal kingdoms (Kazeni, & Mkhwanazi, 2021; Nelson & Hawk, 2020).

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In addition, as one of the tools for correctly disseminating the concepts of life science, continuing professional teacher development (CPTD) is crucial. To keep instructors informed about the newest teaching techniques and scientific advancements, teacher training and development. CPTD includes workshops and seminars, which are crucial to the professionalism of teachers (Kazeni, & Mkhwanazi, 2021).

Teachers teaching life sciences should participate in collaborative networks, which provide forums for exchanging resources, insights, and optimal methodologies. One of the more recent resources utilised by educators is Community and Industry Partnerships, which involve working in conjunction with research institutions and universities. The ability to access cutting-edge scientific information and materials is essential for the effective teaching of life sciences (Ramnarain, Ncube, & Teo, 2023). The involvement of NGOs and environmental organisations is necessary to support environmental education and conservation programmes because of the funding constraints. Industrial assistance and collaborations with agricultural associations and biotech firms for useful information and resources.

Teachers and students are kept up to date on the most recent advancements and research in the field of life sciences through supplemental materials such as scientific publications and magazines. Moreover, instructional films and documentaries. Visual materials to improve comprehension of current topics and concepts in the life sciences. Interactive kits and games can be used to engage learners, and interactive activities and hands-on learning can engage pupils (Ramnarain, Ncube, & Teo, 2023). Students can perform experiments and investigate ideas online with the help of virtual labs and simulations (Ramnarain, Ncube, & Teo, 2023). Teachers can build a rich and dynamic learning environment that improves students' comprehension and appreciation of the life sciences by combining these resources.

The consensus among academics studying scientific education has grown recently. In South Africa, life science is one of the disciplines provided at the secondary school level. An Investigating Phenomenon in Life Sciences section can be found in the CAPS document for the life sciences (DBE, 2011, p. 15). According to page 15, to achieve this goal, students must "...be able to plan and carry out investigations, a well as to solve problems that require some practical ability." "...this ability is underpinned by an attitude of curiosity and interest in wanting to find out how the natural world and the living things in it, work," according to the biological sciences CAPS (p. 15). Using the correct resources is essential for fostering learners' curiosity and enthusiasm for science by requiring them to research natural occurrences. Using the appropriate teaching tools in life science classrooms can improve students' comprehension of the topics and procedures covered in the subject as well as help them acquire relevant cognitive and practical skills (Kazeni, & Mkhwanazi, 2021).

Researchers are becoming more and more in agreement regarding the benefits of employing appropriate resources and pedagogies when teaching life science, however in South African science classrooms, these resources and pedagogies are not often employed. Teachers' reluctance to use modern resources, such as digital resources and technology, could also be partially explained by their lack of knowledge and negative attitudes towards the teaching approach, as well as contextual teaching constraints (Wilkins, 2017). In the life sciences, students frequently learn facts, terminologies, theories, and processes, which they frequently just memorise, without the need for investigations (Kazeni & Mkhwanazi, 2021; Wilkins, 2017).

In this regard, Wilkins (2017) proposed a theoretical framework that connects educators' decisions on instructional techniques to their knowledge, attitudes, and beliefs. Similarly, Kazeni and Mkhwanazi (2021) claimed that educators' decisions and choices of pedagogical tactics could be influenced by their ideas about current technologies and approaches, teaching and learning, and the nature of science. Additionally, educators who have a positive outlook on contemporary resources might make greater use of the best pedagogies. As a pedagogical tactic, teachers' fundamental beliefs may stand in the way of their choice of inquiry if they are at odds with inquiry practices (Mlambo et al., 2020).

The literature also offers refutations to claims that beliefs guide behaviour. One such study is that of Saad and Boujaoude (2012), which is cited in Kazeni & Mkhwanazi (2021). 34 educators in Lebanon demonstrated that having favourable opinions about contemporary pedagogies and technology does not guarantee their application in the classroom. Understanding life science teachers' reluctance to implement

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the use of resources in their classrooms required an examination of their knowledge, perceptions, and practices of certain pedagogies, given the diversity of opinions regarding the relationship between knowledge, attitudes, and practice. The rewriting of educational policies and curricula for life sciences teacher training programmes to prioritise teacher preparation for implementing this pertinent pedagogy should benefit from this information (Mahambehlala, 2019). Hence, the objective of this paper is to explore the availability and utilisation of modern resources for teaching life sciences in some selected schools in South Africa.

Research Questions

The following questions guide this study.

- What are the modern resources available for the teaching of Life Sciences?
- How do the availability and the use of modern resources promote the understanding of Life Sciences in South Africa?
- Why do educators use modern resources to teach Life Sciences in the way they do?

Theoretical Framework

According to the learning paradigm known as constructivism, students build their knowledge via their interactions and experiences with the outside world. Constructivism is more frequently linked to thinkers like Jean Piaget and Lev Vygotsky, even though Albert Bandura is most recognised for his Social Learning Theory (which eventually developed into Social Cognitive Theory) (Adu & Duku, 2023). Nonetheless, there are areas in which constructivist principles and Bandura's theories overlap. Let's examine Bandura's contributions and constructivism concerning them.

Albert Bandura's Social Learning Theory

The significance of seeing, modelling, and copying the behaviours, attitudes, and emotional responses of others is emphasised by Bandura's social learning theory. His approach, which is frequently summed up as reciprocal determinism, incorporates an ongoing interaction between actions, cognitions, and the environment (Adu & Olowu, 2022).

One of the main ideas of Bandura's theory is observational learning (modelling), which is the process of learning by observing how attention, memory, reproduction, and motivation are all involved. Reciprocal determinism is another idea that discusses how personal and environmental elements including emotions, biology, and cognition can affect conduct. Performance and motivation are also influenced by self-efficacy, or the conviction that one can plan and carry out the actions necessary to handle future circumstances(Motloung, Mavuru, & McNaught, 2021).

Behaviours that have an impact on subsequent consequences—which can either reinforce or punish the behaviour—are referred to as reinforcement or punishment (Motloung, Mavuru, & McNaught, 2021). When using the current tools to teach life sciences, teachers must be aware of the attitudes and actions of their students. The way students behave and integrate into the classroom will dictate the dynamics and necessary adjustments to the resources used to teach life sciences.

With the help of teaching resources for the life sciences, students can take ownership of the material being taught and develop new knowledge based on their behaviour. Teachers can be perceptive and aware of the requirements of their students thanks to the social learning paradigm. When given the proper tools or materials, learners are highly engaged; therefore, teachers must offer the assistance required to produce the intended learning outcome (Adu & Olowu, 2022; Motloung, Mavuru, & McNaught, 2021).

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Constructivism and Bandura's theory both highlight how crucial the social context is to learning. Vygotsky places more emphasis on social interaction and cultural context, while Bandura emphasises the importance of observational learning and modelling. According to Motloung, Mavuru, and McNaught (2021), Bandura's theory of self-efficacy and active engagement in learning is consistent with the constructivist perspective of learners actively interacting with their surroundings. However, this can only be achieved with the use of contemporary instructional tools.

In line with the constructivist theory that students create knowledge from their experiences, Bandura recognises that people interpret and make meaning of their experiences. When educators employ pedagogies and instructional materials to teach life sciences, students have better experiences (Alrawashdeh, & Kunt, 2022). Constructivist and social learning theories are similar in that they emphasise social contact, active participation, and the production of knowledge via experience (Motloung, Mavuru, & McNaught, 2021).

Understanding of Life Sciences Through the Availability of Resources

To examine how resource accessibility advances life sciences knowledge in South Africa, the following elements need to be taken into account.

Educational Infrastructure: The quality of life science education is improved by having access to contemporary, well-equipped laboratories and learning resources in schools and universities. This makes it possible for researchers and students to conduct experiments, comprehend intricate biological processes, and keep up with the latest developments in science (Mahambehlala, 2019; Nelson & Hawk, 2020).

Financing & Grants: Financing opportunities for life science research projects aid new studies and discoveries. Grants from public agencies, commercial businesses, and international partnerships allow scientists to advance their fields of study and advance scientific understanding.

Access to Information: Students and researchers can obtain vital information via digital resources, such as online databases, scientific journals, and instructional platforms. Having access to the most recent research articles, e-books, and online courses can greatly improve comprehension and expertise in the biological sciences. (Mahambehlala, 2019).

Programmes for Training and Development: Workshops, seminars, and training sessions provide chances to improve knowledge and acquire new skills. Teachers and researchers benefit from these programmes, which are frequently funded by institutions and organisations, as they aid in their ongoing professional development.

Partnerships and Collaborations: Partnerships and collaborations among academic institutions, research facilities, and business sectors promote a knowledge- and resource-sharing atmosphere. In addition to bringing in knowledge and cutting-edge technology, partnerships with international organisations can foster a deeper comprehension of the life sciences(Mahambehlala, 2019).

Community Outreach and Awareness: Programmes designed to increase public understanding of the value of life sciences and to stimulate involvement in the community can be very effective. Public lectures, science fairs, and outreach initiatives can stimulate young people's curiosity and advance scientific literacy (Mahambehlala, 2019).

Concept of Life Science and Objectives in South Africa

The study of living things and life processes is the main emphasis of the National Curriculum subject known as "Life Sciences" in South Africa. It covers a broad spectrum of subjects, ranging from the cellular and molecular to the ecological and environmental. The course seeks to enhance students' scientific inquiry

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abilities while offering a thorough grasp of biological ideas, principles, and processes. The following are the goals of Life Sciences in South Africa:

- To provide students with knowledge of biological concepts and principles, including the structure and function of cells, genetics, evolution, ecology, and the interrelationships among living organisms.
- To develop students' abilities to conduct scientific investigations, collect and analyze data, and draw evidence-based conclusions.
- To encourage students to apply biological knowledge to real-world problems, such as health issues, environmental conservation, and sustainable living.
- To foster critical thinking and problem-solving skills by engaging students in scientific inquiry and debates on contemporary biological issues.
- To raise awareness of the importance of biology in everyday life and its implications for individuals, society, and the environment (Kazeni, & Mkhwanazi, 2021).

Life Sciences education in South Africa aims to develop scientifically literate individuals who can contribute positively to society and address biological and environmental challenges (Kazeni, & Mkhwanazi, 2021).

Research and Methodology

This section focuses on the procedures and methods used during the entire research project. It entails the selection, evaluation, and contemplation of the methods used in the research process. In particular, the study paradigm, approach, design, sample and sampling procedures, data collection tool, and data analysis are covered in this section (Kazeni, & Mkhwanazi, 2021; Adu & Olowu, 2022).

Research Paradigm

The transformative paradigm, which is used in this work, assumes that power is a problem that needs to be addressed throughout the entire research process. The availability of contemporary teaching resources for the life sciences has emerged as a challenge that opens doors to new scientific areas. Early in the research process, deciding on the direction of the study emphasis is an important decision (Creswell, 2014; Kazeni, & Mkhwanazi, 2021).

Research Approach

Because it incorporates a social and natural environment where people experience the parts of their lives and interact with chosen others in their settings, the qualitative research approach is adopted in this work (Adu & Olowu, 2022; Kazeni, & Mkhwanazi, 2021). It also implies how interactions between learners are shaped, acted upon, and interacted with by the availability of resources.

Research Design

For this work, a phenomenological case study design was chosen because it allows for a thorough comprehension of occurrences using semi-structured, in-depth interviews that record the participants' lived experiences. This would enable people to comprehend how the resources at their disposal support the teaching of life sciences (Kazeni, & Mkhwanazi, 2021; Adu & Olowu, 2022).

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Sampling and Instrumentation

For this study, eight teachers from four schools in Buffalo Metropolitan City, East London, South Africa, were selected using judgement and purposeful selection techniques. The respondents were questioned in a semi-structured interview manner to gather information.

Trustworthiness

Credibility, transferability, dependability, and confirmability are all guaranteed when participants are allowed to view the research's conclusions and provide their assent (Creswell, 2014; Adu & Olowu, 2022). By using the data they had gathered, the researchers attempted to avoid any kind of data manipulation and to accurately and impartially represent the perspectives of the research participants.

Data Analysis

Thematic analysis of the data involved familiarising oneself with the data, creating a code, looking for the theme, and transcribing the data. The research questions served as the basis for the subject (Creswell, 2014).

Data Analysis and Findings

The data were analysed using a thematic approach according to the research questions postulated in this paper.

Research Questions 1

What are the modern resources available for the teaching of Life Sciences?

Table 1. Theme and Sub-Themes Concerning the Modern Resources Available for The Teaching of Life Sciences

Theme	Sub-themes	Activities
Modern resources available for the teaching of Life Sciences	PowerPoints presentation	• We use PowerPoints slides with the help of overhead projector and laptop to disseminate information to our learners
	YouTube	• Teaching and learning are happening online in this 4th industrial revolution using videos clips from YouTube
	Telematics	• Telematics and electronic notebooks are being used to be relevant as teachers in this 21st-century

Theme 1: The Modern Resources Available for the Teaching of Life Sciences

All the respondents believed that the availability and use of modern resources are very important in this dispensation because of the advent of the COVID-19 pandemic and 4IR. However, some participants enunciated the following.

P2: since we are in the 4th Industrial Revolution more teaching and learning is happening online using tools like Google, WhatsApp, TikTok, YouTube, PDF notes and projection.

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P5: The modern resources available in my school are audio-video, computers, Internet, laptops, online tests, electronic notebooks and talking dictionaries.

P8: In my teaching, I use resources like artefacts, human and animal skeletons, plants, videos, microscopes and overhead projectors.

P3: Google form unto marketing techniques is largely used in teaching life science in our school nowadays.

P7: We use magnifiers, magnet models, scales, beakers, cylinders, smartboards, whiteboards, and the Internet.

Discussion on the Modern Resources Available for the Teaching of Life Sciences

The availability and use of modern resources have become the trend in teaching and learning of Life science in schools. COVID-19 which led to virtual classrooms warrants the use of modern resources. The availability of modern resources encourages both teachers and learners during Life Sciences classroom activities (Mahambehlala, 2019; Nelson & Hawk, 2020).

Research Question 2

How do the availability and the use of modern resources promote the understanding of Life Sciences in South Africa?

Table 2. Theme And Sub-Themes Concerning the Use of Modern Resources to Promote the Understanding of Life Sciences in South Africa

Theme	Sub-themes	Activities
The use of modern resources to promote the understanding of Life Sciences	Fostering collaborative learning environment	• Active engagement of learning process • Synthesize information and concepts rather than using rote memorization of facts and figures.
	Interactive and immersive learning experience	• Learners are provided with dynamic and visual representations • Understating challenging topics
	Learners' attention and interest	• Less fatigue due to the watching of videos clips.

Theme 2: The use of modern resources to promote the understanding of Life Sciences in South Africa

The participants reiterated the importance of using modern resources in teaching Life Sciences for better understanding. They believed that using modern resources allows learners to synthesize information and apply it. lt helps learners to navigate difficult topics and promotes learners' interest because it removes boredom and promotes fast learning to make learners grasp easily. A few of the participants have the following to say.

P1: the use of modern resources gives learners and teachers a wealth of experience and allows easy accessibility to research topics and articles.

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P6: The theoretical work is made easier to understand through practical work and the use of YouTube videos involves many senses which generate learners' attention and interest

However,

One participant said, "I personally think that using modern resources does not promote the understanding of Life Sciences because learners become too lazy to study knowing that they will watch videos and read in bed through their phones to cram and pass" (P4)

Discussion on the use of modern resources to promote the understanding of Life Sciences in South Africa

The availability and use of modern resources inform personal decisions and impact scientific knowledge (Mahambehlala, 2019). Learners understand better and learning becomes practical. The use of modern technology in teaching and learning Life Sciences provides dynamic and interactive tools that engage learners in ways best known to them (Nelson & Hawk, 2020). Apart from promoting the understanding of Life Sciences, it allows teachers to make informed decisions that affect their profession and lives.

Research Question 3

Why do educators use modern resources to teach Life Sciences in selected schools the way they do?

Table 3. Theme and Sub-Themes Concerning the Reasons for Using Modern Resources to Teach Life Sciences in South Africa

Theme	Sub-themes	Activities
Reasons for using modern resources to teach Life Sciences	Enhancing learner's understanding	• Learners progress, excelling and understand better
	Enhancing critical thinking	• It helps to enrich opportunities to explore complex concepts • Promotes continuing professional development
	Learning individually, acquire responsibility and independence	• Less fatigue due to the watching of videos clips.

Table 3: Theme and sub-themes concerning the reasons for using modern resources to teach Life Sciences in South Africa

Virtually all the participants confirmed that the reasons for using modern resources to teach Life Sciences are to enhance hands-on experience, memory and better understanding of concepts being taught in school. Some teachers have the following specific reasons to say.

P2: Life Sciences needs critical thinking to navigate complex concepts, hence, there is a need to use fascinating resources.

P7: Using modern resources broadens the knowledge, gives the learners good exposure and promotes a better understanding of the subject.

Discussion on the reasons for using modern resources to teach Life Sciences in South Africa

Life Sciences as a subject can develop the recipients as scientific individuals who can promote critical thinking and contribute positively to the society they belong to. The subject helps learners to address biological and environmental challenges they might face in their lives (Kazeni, & Mkhwanazi, 2021). Using modern resources to teach Life Sciences produces positive results and helps to achieve learning outcomes.

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Conclusion and Recommendations

This paper explores the availability and utilisation of modern resources for teaching Life Sciences in some selected schools in South Africa. The respondents believed that the availability and use of modern resources are very important in this dispensation because of the advent of the COVID-19 pandemic and compliance with the features of the Fourth Industrial Resolution (4IR). The importance of using modern resources in teaching Life Sciences for better understanding, allows learners to synthesize information and apply it. Also helps learners to navigate difficult topics, promotes learners' interest and makes learners grasp easily is alluded to in this paper. Therefore, the paper shows that the teaching and learning of Life Sciences will be meaningless without the use of modern resources

The following are recommended.

- The teacher should update their knowledge in the use of modern resources for teaching Life Sciences.
- Resources should be used following the subject matter and the grade level of the learners.
- The maintenance of the resources should not be the sole responsibility of the schools, parents and government partnership are essential because of cost implications and school location.

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