Integrating skills and competencies through practical work as a pedagogy for adequate teaching and learning of school Life Sciences

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Abstract- Most science educators see practical work carried out by students as a crucial part of Life Sciences education. This study outlines the importance of integrating practical work as pedagogy in teaching Life Sciences at the purposively sampled schools. The integration of practical work in teaching and learning of Life Sciences at schools is crucial, as it increases the interest of learners in the subject and promotes greater academic outcomes. It also contributes to learners' gaining scientific skills and competencies that are an important foundation of scientific reasoning. This study aimed to gain insight on integration of practical work, as a pedagogy for adequate teaching and learning of school Life Sciences. The research focussed on teachers' perceptions in using practical work as one of key teaching and learning strategies for Life Sciences. The challenges faced by Life Sciences' teachers regarding the integration of practical work in the pedagogical content knowledge of Life Sciences' disciplinary knowledge is outlined in this empirical research. Constructivism was selected as theoretical framework underpinning the data collection, analysis and discussion of findings. Qualitative research methods of data collection and analysis, which include interviews and observation, were used for data collection and explication. The analysis of data was done using deductive reasoning. Ethical considerations were taken cognisance of throughout this study. Results unveiled that teachers do not use practical work due to the following reasons: lack of experience of novice teachers, inadequate or lack of resources and lack of time allocated for practical work in the curriculum.

Key words: Life Sciences, Pedagogy, Practical work, Constructivism, integration, schools, South Africa.

I. INTRODUCTION

Life Sciences is one of the most interesting and fascinating subjects, yet it is one of the subjects that have poor performance at the end of National Senior Certificate (NSC) matric examinations, compared to other subjects. There are a number of factors that contribute to this kind of performance in Life Sciences. Chief among these is attributable to the poor integration of skills and competencies required for adequate teaching and learning of Sciences disciplines at the senior phase level, in Natural Science (Broad-based discipline consisting of Chemistry, Physics and Life Sciences). Research argues that learners learn best when they are involved in knowledge construction and, hence, lack of practical work in the laboratory and in the field makes teaching and learning the subject to be less effective. Some schools particularly in rural and township areas lack basic resources needed to cater for the practical needs of the subject (Kanamugire, Yadav & Mbonyiryivuze, 2019).

Many topics in Life Sciences need practical work to make the content interesting and contribute to the learning acquisition process of the learners. For example, when teaching about organs, it is more effective to do a dissection with the learners, so that they can relate the practical knowledge to the content knowledge. The lack thereof has resulted in Life Sciences, which is a science discipline, being taught inadequately. Sciences disciplines require practical work that is done at the laboratory or on the field (field trips). From this practical knowledge, learners gain skills and competencies, such as inquiry-based learning, measurements, basic scientific calculations, sampling, and many other skills that the subject offers (Kibirige & Mapony,2021). A study conducted in South Africa by Maboyi & Dekkers (2003) revealed that almost all the Natural Science teachers in their study preferred teacher demonstrations due to the lack of laboratories and laboratory equipment, among other reasons. Findings from Lee & Sulaiman (2018) showed that students who conducted science practical work indeed performed better than students who were taught by using traditional teaching methods. They further postulated that, if practical work is well designed and delivered following sound scientific methods by the teacher, it may yield positive results in learning and teaching of sciences. Hence, this study explored the effect of integrating practical work as a pedagogy for teaching and learning of school. Life Sciences. This pedagogy is rooted in inquiry-based strategies for teaching and learning in Life Sciences.

II. LITERATURE REVIEW

Kroila et al. (201p) argue that the essence of the study of science requires the integration of experimental design in a form of practical work. They further postulate that practical work helps to evoke and maintain learners' interest in the science discipline and, therefore, helps to promote learners' participation in the classroom. According to Millar (2008), practical work helps learners gain analytic and problem-solving skills, which are essential in the learning of science. He further argues that practical work helps science to develop a deeper understanding of scientific methodology, which allows them to be able to make hypothesis, collect and analyse data, do sampling, analyse, and make scientific sound findings and conclusions. Ngiphandulwa, Kapenda and Kasanda (2019) assert that practical work in science promotes the development of skills, collaborative learning, and improves overall scientific and analytic skills of learners.

Millar (2004) contends that, when teachers use practical work when teaching Science, students' knowledge can be expanded to better understand the world and solve daily problems. Madukwe, Onwuka and Nyejirime (2019) argue that teachers' perceptions and attitude towards practical work is a major determinant of a learners' view towards practical work. this, in turn, influences whether the practical work will be used in the classroom. They further argued that teachers who have a positive attitude towards practical work tend to integrate it more in the lessons, leading to better learning and teaching of science. They contend that teachers' attitude towards practical work is influenced by a wide range of factors that include availability of resources, competence of conducting practical work, time, curriculum coverage and many others.

Malathi and Rohini (2018) contend that practical work is, in most cases, allocated insufficient time, which makes it difficult for teachers in many under-resourced schools to use it. Due to the shortage of resources and overcrowded classes in under-resourced schools, this presents a great challenge to teachers. They further argue that teachers are coerced to stick to the Annual Teaching Plans (ATPs) that emphasize more theory than practice. This theory-inclined approach takes more teaching time, resulting in less time allocated for practical work. These are contributing factors that hinder effective practical work. The lack of laboratories and laboratory equipment presents a big problem to science teachers.

Atamofa (2014) postulated that social constructivists, such as Piaget and Vygotsky, highlight the importance of the learner being actively involved in the learning process. Park & Song (2019) further explain that the active involvement of learner in knowledge construction is the best way to promote effective learning and teaching. It is believed that learners with different skills and backgrounds need to collaborate. Atomatofa (2014) reveals that constructivism is rooted in three branches of constructivism, which are cognitive constructivism, radical constructivism, and social constructivism. Cognitive constructivists focus on cognitive development, and it is concerned with mental constructions of reality. Radical constructivists emphasize the construction of a cohesive reality based on experiential construct. Social constructivists emphasize the construction of socially agreed realities.

Park & Song (2019) assert that constructivist science classroom is the opposite of the realist and behaviorist science classroom, where the teacher is supposed to become a source of knowledge about reality and impart it to children in a way. Constructivist science classes are more focused on giving learners opportunities to perform experiments and practical work that will help them construct knowledge in a meaningful way that will have a long-lasting impact on their understanding of reality. The constructivist instructional method requires strategies that allow the learners to be part of the knowledge creation. The teacher in a constructivist class acts as a guide and gives learners necessary support needed for them to start contrasting knowledge. Ngala's (2019) findings show that the use of laboratory-based teaching allowed learners to gain more basic science process skills, as opposed to the conventional teaching method. This shows that practical work allows learners to construct knowledge and, in the process, gain valuable skills.

III METHODOLOGY

The study was based on the qualitative research method. Data collection was done through qualitative research methods of in-depth interviews and observations. The data collection employed qualitative methods to analyse existing Life Sciences literature. Deductive theory was used to analyse the literature. Literature has declared that human behaviour is multi-layered and cannot, therefore, be determined by pre-defined probabilistic models, since human behaviour depends on shifting situations and unique circumstances determined by environmental factors, other than probabilities.

Purposive sampling was used to sample the participants, as it presented an easy process of selecting the participants, as they were already known by the researcher. This sampling technique relied on the judgement of the researcher when it comes to selecting the study units or data sources that are to be studied (Sharma,2017). In-depth interviews were conducted with three Life Sciences and Natural sciences teachers teaching at one school (Good Hope seminary high school). Prior to the interview process, semi-structured questions were prepared. The three teachers were selected based on their subject specialisation and their back exposure to practical work or the laboratory environment.

Data collected was synthesised and analysed using deductive theory. Sharma (2017) explains that deductive theory uses deduction to test the phenomena using existing theories to [WORDS OR WORD MISSING HERE, PLEASE COMPLETE]. It involves using the existing theories and applying them to explain phenomena being studied. Deductive reasoning begins with generalisations and seeks to see if these generalisations apply to the context of the study.

It was necessary for the researcher to use observations with interviews for triangulation purposes, thereby ensuring that the findings are trustworthy. Triangulation is defined as "a qualitative research strategy to test validity through the convergence of information from different sources" (Carter, Bryant-Lukosius, Di Censo, Blythe, & Neville, 2014).

IV. RESULTS AND DISCUSSION OF FINDINGS

1. Findings from the in-depth interviews

Data from interviews indicated that there are varying factors leading to different perceptions of teachers towards the integration of practical work in teaching and learning of Life Sciences. Data obtained from the interviews and analysis of teachers' interviews used in this study were all designed to answer two important questions. These were:

- Did you think the use of practical work is important in teaching and learning of Life Sciences?
- What challenges are you facing when it comes to using practical work to teach Life Sciences?

Results obtained showed that Life Sciences teachers have differing perspectives, when it comes to the importance of practical work in the teaching of high school Life Sciences. Lack of experience to conduct practical work was mentioned that as one of the negative detriments of practical work. Literature review concurs with this finding, as Millar (2004) and Madukwe, Odukwe & Nyerijime (2019) contend that the attitudes, experiences, and skills of teachers towards practical work directly and indirectly affect the practice of integrating practical work in the sciences disciplines at school. This shows that novice Life Sciences teachers should be mentored and supported for them to be able to perform practical work. It is assumed that the novice teachers come with skills from university, but findings indicate that support is still needed. Workshops should be organised to equip novice teachers with practical work skills, so that they can be confident in their approach. Teachers who are experienced and competent in conducting practical work in the schools should be tasked to assist novice teachers gain necessary skills to engage learners in practical activities, as they learn sciences. Consequently, this will improve learners' deep understanding of scientific method in learning the science in its nature (Gadula, 2017).

Time constraints and heavy teaching loads were also mentioned hindrances to the integration of practical work in Life Sciences. It must be noted that findings also indicate that teachers understand the importance of practical work. Data from interviews showed that some teachers have heavy teaching loads, which make it difficult for them to make time to do practical work. While they understand the importance of practical work, they feel like it takes more time. This finding demonstrates that practical work, which is a critical skill for adequate teaching and learning of Life Science, is not prioritised, thus depriving learners of constructing knowledge at the expense of pushing information that impedes the adequate teaching of the disciplinary knowledge through inquiry-based strategies, as in the nature of sciences (Atomatofa, 2014; Park & Song, 2019; Crawford, 1996; Ngala, 2019).

Findings from interviews indicate that teachers face challenges such as shortage of practical work or laboratory materials. The shortage of enough laboratories or laboratory materials makes it difficult for some teachers to conduct practical work. Studies conducted globally and in Africa showed that this is, indeed, a challenge in schools with lack of adequate resources to develop conceptual understanding through practical activities in Life Sciences (Malathi and Rohini, 2018; Kanamugire, Yadav & Mbonyiryivuze, 2019).

2. Findings from in situ observations

At the schools where the study was conducted, there was a huge lack of mentoring and support to novice teachers. Therefore, these teachers need to be supported by experienced and competent teachers in the school. Furthermore, it was established that there is a lack of resources for conducting practical work. Principals and government officials responsible for funding schools must allocate capital or financial resources to procure laboratory-materials and build enough laboratories, where needed. Nevertheless, it was also observed that when applied correctly, practical work helps to keep learners engaged and help them to grasp concepts more effectively and give them analytical skills.

V. CONCLUSION

This study concludes that Life Sciences teachers have differing perspectives regarding the importance of practical work in the teaching of high school Life. Lack of experience to conduct practical work was mentioned as one of the negative detriments of practical work. This shows that novice Life Sciences teacher should be mentored and supported for them to be able to perform practical work. The schooling system has an assumption that the novice teachers come with skills from university, but findings indicate that support is still needed. Therefore, together with mentorship, workshops need to be organised to equip novice teachers with practical work skills, so that they can be confident in their approach inquiry-based approach to teaching and learning.

Time constraints and heavy teaching load was also mentioned as a hindrance to the integration of practical work in Life Sciences. It must be noted that, findings also indicate that teachers understand the importance of practical work. Data from interviews showed that some teachers have heavy teaching loads, which make it difficult for them to make time to do practical work. While they understand the importance of practical work, they feel like it takes more time.

Furthermore, it was established that there is a lack of resources for conducting practical work. Principals and government officials responsible for funding schools must allocate capital or financial resources to procure laboratory-materials and build enough laboratories, where needed. Nevertheless, it was also observed that when applied correctly, practical work helps to keep learners engaged and helps them to grasp concepts more effectively and this gives them analytical skills. Where possible, schools should approach non-governmental organisations, private companies, government departments and other stakeholders to ask for donations to build more laboratories and procure practical work materials.

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