12 (3) (2023) 154-159

Unnes Science Education Journal
Accredited Sinta 3

https://journal.unnes.ac.id/sju/index.php/usej

Reflections on the Science Centre Education Officers as They Enhance the Teaching and Learning of Science

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DOI: http://dx.doi.org/10.15294/usej.v12i3.74249

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Article Info

Submitted 2023-09-07
Revised 2023-10-02
Accepted 2023-11-10

Keywords

science centre, science education, education officers, content knowledge, exhibits

Abstract

This qualitative interpretative case study explored in detail the use of exhibits to enhance the teaching and learning of science by a science centre in Pretoria, South Africa. The study was guided by the following research question: what are the reflections on the science centre education officers as they enhance the teaching and learning of science? Two education officers were purposefully sampled as participants in this study. Data were collected through observation and semi-structured interviews. Findings revealed that indeed exhibits are the major component of the science centre, however, some education officers do not have the content knowledge (CK) of the exhibits, some visiting schools do not understand the use of the exhibits to enhance the teaching and learning of science. It is recommended that education officers should receive proper training on the content knowledge of the exhibits and visiting schools must be encouraged to fully participate in the teaching and learning at the science centre. Teacher's workshop should be coordinated to encourage teachers to use the exhibits for teaching and learning at the centre. School curriculum should include visits to science centres for practical projects to enhance the teaching and learning of science.

How to Cite

Bilankulu, H. J., Mudau, A. V., & Ntuli, T. G. (2023). Reflections on the Science Centre Education Officers as They Enhance the Teaching and Learning of Science. *Unnes Science Education Journal*, 12(3), 154-159.

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p-ISSN 2252-6617
e-ISSN 2502-6232

INTRODUCTION

Increasing the understanding of Science, Technology, Engineering and Mathematics (STEM) in the learning process is the main agenda for the global education system (Talib, 2020). The need to cultivate learners' attitude and understanding of science through dialogue and the motivation through interaction to learn science is the drive in the development of a knowledge-based society (Falk and Dierking, 2017). Science centres and museums play a major role in enhancing the teaching and learning of science through interactive exhibits. The world is moving into a knowledge-based society and South African cannot be left behind.

There is a serious concern about the level of science education in South Africa (Fish, 2017). The alarming findings that South African learners continue to underperform in science and mathematics education is a serious concern (Manda and Dhaou, 2019). In another Trends in Mathematics and Science Study (TIMSS) that was conducted where South Africa participated in Grade 9 level, South Africa has shown some improvement (Reddy, Visser, Winnaar, Arends, Juan & Prinsloo, 2016). However, in the 2015 study, South Africa still falls among the five lowest performing countries in science and mathematics. (Reddy, 2021) argue that considering the poor performance by South African learners in science, teaching and learning in science education must be enhanced.

The number of learners doing science at school level in South Africa is also declining (Department of Science and Technology, 2016). According to Maluleke (2019) some high school learners perceive science subject to be difficult and demanding. Mushaikwa (2014) argue that learners leave science subjects to choose other subjects that are perceived to be less demanding, and the learners believe that they will do better in those subjects. Learners see science as abstract subjects which do not have any link with their everyday life. There is a decline in science activity that can arouse learners' interest in science education (Maluleke, 2019). As such Schulze and Heerden (2015) indicate that science education in South Africa needs serious attention.

Consequently, science centres were created to mitigate these negative perceptions about science. In brief, the purpose of science centres is to popularise science by making it more interesting and encourage learners to study science and choosing science careers (DST, 2016). These centres aim to achieve these through science exhibits and lessons that are linked to the school curriculum (DST, 2014). According to the researcher's observation, some of the schools that visit the National Zoological Gardens had no ideal on how the institution can help them to learn and understand science on a practical level. Schools visited the centre just to relax and be out of the formal schooling (Mosabala, 2014). The schools did not explore the science concepts and principle that were exposed to them at the National Zoological Garden. For an example, learners did not fully interact with the science display and exhibit at the centre. Some schools did not see it as a learning institution, they saw the centre as a place to relax. Employees (education officer) at the centre did not pay much attention on the interaction between the learners and the exhibits.

Science centres and museums play an important role in engaging learners to study science, and their leisure setting provides a medium through which learners can acquire scientific information and develop ideas for themselves and their societies (Person, 2018). These centres have positioned themselves well in societies' collective knowledge and as sites for public science education. They function in a way as to complement formal education by promoting science literacy (Tayer, 2019). It is vital for learners to visit these centres to get motivated and have a better understanding of science through exhibits.

Interactive lessons and exhibits at science centres and museums are credited for being hands-on which is pedagogically superior to traditional way of transmitting knowledge (Cox, 2019). Science centres and museums offer a model of experiential learning that has a direct encounter with the phenomena rather than a mere thinking about the encounter (Eshach, 2016). It is a unique platform for science engagement (Person, 2018). Watermeyer (2012) argues that the *modus operandi* of science centres and museums encourages social interaction which evokes scientific discourse.

Science centres have science exhibits that are used to teach learners about science concepts and principles. The research question explored in this study is "what are the reflections on the science centre education officers as they enhance the teaching and learning of science?

METHOD

The research methodology used in this article is a qualitative case study approach. In this methodology words are used as data to understand and interpret more local meaning by using

data gathered in a context to produce general understanding (Yin, 2016). Braun and Clarke (2013, 21) argue that qualitative research is exploratory, open-ended and produce in-depth, rich, and detailed data from which to make claims. The researcher chose this methodology because it connected well with the purpose and the research question of this study. As argued by Richards and Morse (2013) that the researcher actively creates the link between the purpose and the method to be used. A multiple case study design was used to understand the use of exhibits to enhance the teaching and learning of science at the science centre.

A purposeful sampling was used to select two participants on this study. Purposeful sampling involves the selection of participants because of their characteristics, which are those who are willing to reflect on the phenomena of interest and they are willing to participate (Richards and Morse, 2013). According to Richards and Morse (2013), sampling is key to good qualitative inquiry; it helps to understand the dilemmas of qualitative validity. Two education officers were purposefully sampled on the bases that they have a qualification in Natural Sciences, they were trained to facilitate teaching and learning at the centre, and they are willing to participate on the study.

Qualitative data were collected from the two participants, each case was treated and analysed separately because this was not a comparative case study. For this research the following techniques were used to collect data, namely; semi-structured interviews and observations. This is called triangulation method, where multiple data sources are used to produce a greater depth and breadth of understanding. This method corroborates findings and builds a more holistic picture of the phenomenon (Billups, 2014). Participates were interviewed before the lesson presentation and after the presentation and they were also observed during the presentation. These was done to gain an in-depth understanding of how exhibits are used to enhance the teaching and learning of science at the science centre.

After data were collected the researcher used an ethnographic approach to analyse the data. According to Richards and Morse (2013) in ethnography the segments of data may be considered as pieces of a puzzle that fit together to give a complete, holistic, and rich description. Each case was analysed separately to understand how exhibits are used to enhance teaching and learning at the science centre.

RESULTS AND DISCUSSION

The results from each case are presented separately.

Case 1: Musa

The first education officer who participated in this study will be called Musa.

Musa was observed and interviewed on his lesson. The lesson he presented was on "Understanding South African Biodiversity". He had a station and displayed different specimen, biofact materials and staffed animals to teach learners about South African Biodiversity, His station was adjacent to the Vulture enclosure. Researchers such as Ramey- Gassert (2016) and Cox (2019) argue that science centres and museums can draw in learners, science equipment and learners get the potential chance to see and feel the exhibits. Science centres and museums are fit for giving hands-on activities that can energize learners and urge them to learn science in a non-evaluative and loosened-up setting. Science centres and Museums can connect with learners through intriguing activities, through exhibits which empower learners to lead logical tasks and upgrade decisive reasoning (Bencze and Lemelin, 2001).

This has been confirmed by Musa. When asked about the use of exhibits to enhance teaching and learning he said:

" I think the use of exhibits and interactive activities are very effective. It's a very effective method of teaching because from what I have noticed so far, the use of the exhibits makes the learners very interested to want to know how they work. The exhibits, I think are a very main thing because it makes them want to learn more if they see something rather than hearing words about it. So, if you have a certain activity that you are using, they will be more interested in that, because when they approach the station, they will see all the exhibits. So, from the beginning, they will enter, they want to know more."

From the above explanation is clear that the exhibits play an important role to enhance teaching and learning at the station where Musa is teaching about "Understanding South African Biodiversity". Learners at his station showed interest because the exhibits displayed.

Musa was observed teaching learners about the importance of food-chains and food-web. He said:

"Food web illustrates which organism eat which one, starting with the grass to the lion. You have grass as producers, herbivores as primary consumers and Lion as a secondary consumer,

these are categories we use in food webs".

One learner asked: "what about a human being on this food web"?

Musa said: "you can replace the Lion with a human being".

Musa's answer was not correct. It was clear that Musa did not have the content knowledge of the exhibits. His explanation of a food web was lacking. He could have used the correct concept of energy flow to explain food chains and food webs. His explanation of primary consumers as herbivores and a Lion being a secondary consumer on his food web was also incorrect. Musa had an opportunity to include Vultures as part of his lesson to explain the tertiary consumers, but he did not. His station was next to a Vulture enclosure, it would have made more sense to use Vultures as part of his exhibits.

It is clear from the above that Musa's Knowledge of the exhibits is lacking. Musa battled to answer a learner's question on "what about a human being on this food web"?. Musa was observed battling to understand where a human being will fit on his food web. All he said was "you can replace the Lion with a human being". He did not explain why. His explanation was not accurate. He could have included a human being as a tertiary consumer on his food web.

According to Shulman (1986), content knowledge represents teacher's understanding of the subject matter taught. "It is the amount and organisation of knowledge per se in the mind of the teacher" (Shulman, 1986.9). This argument is supported by Tran and King (2007), where they state that content knowledge refers to an understanding of the structure of the subject matter and its epistemology. According to Reiss (2018) the education officer needs to not only understand that something is so, but the education officer must also further understand why it is so, thus the emphasis is on a deeper understanding of the subject matter taught. Based on the above explanation of the subject matter, it is very clear that Musa's content Knowledge is lacking.

When asked about the other schools groups that were passing and not attending to the lesson at his station Musa said:

" some schools do not understand that there is a learning opportunity on this exhibits, they come look at them and say they are in harry, they can't wait and learn. Mainly teachers, kids are interested by their teachers are telling them that they don't have time."

Some schools do not understand the importance of teaching and learning that takes place at the science centre. They only want to see the exhibits and leave the station. Schep, et al (2018) in their studies of schools visiting museums found that very little is done in the preparation for the visit. Most teachers hardly understand the objective of the visit to the museum.

Case 2: Zanele.

The second education officer who participated in the study will be called Zanele.

Zanele was observed and interviewed at her station where she displaced microscopes and other apparatus used in a science laboratory. Her station allowed learners to interact with microscopes and use slides to view under the microscope.

Reiss (2018) argue that interactive activities and displays at science centres and museums are credited for being involved, drawing in and stimulating, which is more academically acknowledged than the traditional approach of teaching science to learners.

Zanele confirmed the importance of exhibits to enhance the teaching and learning of science. She said:

" It is important for learners to come to the National Zoological Garden to learn science because we have interesting activities and many exhibits that make us to teach science in an interesting way, they won't forget what they learned at the Zoo."

Zanele indicated that the National Zoological Garden is a good platform where visiting learners and teachers can learn science through interactive activities and the exhibits placed around the centre. Eshack (2016) confirms that the collection at science centres and museums provides learners with the opportunity to see and touch the exhibits, ask questions about them, and place them within context for the development of scientific and technological understanding. Cox (2018) argue that science centres and museums can offer a model of experiential discovery that has an immediate experience with the peculiarities rather than simply pondering the experience. Learners' visit to a science centre or museum is generally an encounter that can't be effortlessly neglected, it is dependably an enduring impression to the meeting learners.

Zanele was observed explaining the difference between a microscope and a telescope. She said:

" Telescope is used in astronomy and a microscope is used in life sciences to see micro-organisms"

The explanation by Zanele was lacking. She had both instruments on her station

displayed. She could have used the instruments to explain the differences between a telescope and a microscope, that would have assisted learners to understand the differences and their use in science. Zanele did not know her exhibits very well. She could have used the telescope to demonstrate how to see far object, but she only focused on the microscope only and used the microscope to show learners specimen. Zanele also confused the compound light microscope with the dissecting microscope. She had a dissecting microscope in her hand explaining how it works but referring it to a compound light microscope. That created a misconception amongst the learners. According to Suprapto (2020) Zanele explanation of compound light microscope using a dissecting microscope will create a misconception to the learners. Learners might think that the explanation given is for the dissecting microscope, they will leave the station with the memory of the microscope used for the explanation.

Zanele's content knowledge of the exhibited microscope is lacking and can be confusing to the learners that attended her lesson.

When Zanele was asked about her exhibits at her station she indicated that some schools were only interested in seeing the exhibits, they did not stop to learn about the microscopes and how they are used in laboratories. Some schools were saying that they don't have enough time to wait and learn about the exhibits. McClaffey (2014) also confirms in her study where some groups were never engaged in the learning activities provided at the museum. Falk and Dierking (2000) also found that some school groups only visit to have fun not to get involved in the learning and teaching activities at the museum.

Science centres and museums are great resources for teaching and learning. They provide learners with a unique context to think about science and technology outside the formal school environment (Cullen, 2005). Musa and Zanele confirmed that exhibit are the main resources for the science centre.

Many researchers such as Eshack (2016), Cox (2019), Reiss (2018), Schep, et al (2018) and Persson(2018) praises science centres and museums for the collection of interactive exhibits that play an important role in teaching and learning of science Not much has been said about the education officer based at those science centres and museum on how the use the exhibits to facilitate teaching and learning.

The study revealed that some education officers at those centres do not have enough knowledge of the exhibits. This was clear from Musa who could not explain the concept of energy flow from one organism to another. Musa had the exhibits to explain the food web, but his knowledge of the resource was inadequate. Yapicis (2018) confirmed that science knowledge from the science centres should be up to date and appropriate to the level of the learners for them to have a better understanding of science concepts.

It is also revealed that when resources are not use appropriately, they can create misconceptions to the learners. Zanele confused learners with using a dissecting microscope to explain a simple compound microscope. Learns might miss to understand the difference between the two microscopes that were displayed by Zanele. Reiss (2018) further argue that if science learning is rarely substantial, misconceptions are initiated or fostered in science centres and museums.

The finding in this study reveals that some education officers lack the content knowledge of the resources used by science centres to enhance the teaching and learning of science.

It is also noted in this study that some schools do not have a clue on the scientific knowledge available at the science centre. Schools were seen reluctant to learn, stating that they do not have enough time to engage in the teaching and learning process. It was revealed that some schools do not see the National Zoological Garden as a centre for scientific knowledge. They have shown little interest on teaching and learning process at the centre. According to Rennie and McClafferty (2016) science centres and museums are seen as edutainment institutions where entertainment is more emphasized that the real learning of science. According to Mkhize (2020) museums are being criticized for being playgrounds where learners are being entertained that learning science.

CONCLUSION

The findings from the two participants confirmed that exhibits are the main attraction for the science centre to enhance the teaching and learning of science. These exhibits are used to illustrate and assist learners in science knowledge construction.

It is also revealed from the two participants that content knowledge of the exhibits that are used to enhance the teaching and learning of science is lacking from the two participants. It therefore recommended that education officer must receive intensive training on the content knowledge of the exhibits.

The finding also revealed that some

schools do not understand the importance of the learning and teaching activities in the science centre. Some schools visit the centre for other reasons that to enhance the teaching and learning of science. It is therefore recommended that the centre should organise many workshops with teachers and inform schools of the opportunities for teaching and learning science at the science centre. It is also recommended that curriculum developers should incorporate science centre in the curriculum for schools to do projects at the science centre.

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