

Using an inquiry-based approach to enhance grade 3 learners' basic science concepts development

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Suggested Citation:

Nhase, Z., Okeke, C.I.O. & Ugwuanyi, C.S (2021). Using an inquiry-based approach to enhance grade 3 learners' basic science concepts development. *Cypriot Journal of Educational Science*. 16(3), 1065-1072. <https://doi.org/10.18844/cjes.v16i3.5825>

Received from December 23, 2020; revised from March 20, 2021; accepted from June 02, 2021.

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Abstract

This study explored Grade 3 teachers' use of an inquiry-based approach to mediate the development of basic science concepts among learners within the socio-cultural theory. This study adopted interpretive case study research of the qualitative type, using a sample of four (4) female teachers who use the home language of learners as the language of instruction. Data were collected using a semi-structured interview guide and observational schedule which was properly validated. Analysis of data was achieved through thematic data analysis. The result of the study revealed that the foundation phase teachers are aware of the importance of the use of the inquiry-based approach in mediating the development of basic science concepts by the learners, but only one out of the four participants implemented it. Thus, it was recommended that there should be a provision of further professional development spaces that promote a community of practice in using an Inquiry-Based Approach in the Foundation Phase.

Keywords: Basic science concepts, Grade 3 teachers, Foundation Phase, Inquiry-Based approach

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1. Introduction

1.1 Background and statement of the problem

In the global context, studies (Agboeze et al., 2020; Ugwuanyi, Okeke & Njeze, 2020; Benson et al., 2020; Inyama, Nwagbo & Ugwuanyi, 2020; Ugwuanyi et al., 2019a; Ugwuanyi et al., 2019b; Ugwuanyi & Okeke, 2020; Ugwuanyi, Okeke, & Ageda, 2020; Onah et al., 2020; Njoku et al., 2020;) have noted the decline in the achievement of learners in science subjects including basic science. This abysmal performance of learners in basic science could be attributed to the non-implementation of the inquiry-based approach in some countries (Inyama, Nwagbo & Ugwuanyi, 2020; Benson et al., 2020). For instance, the implementation of an inquiry-based approach has been a problem for many South African teachers, despite the growing consensus on the value of such an approach in teaching and learning (Ramnarain & Hlatswayo, 2018). It has been reported that students have lost interest in school science due to the non-implementation of such a student-centered approach like inquiry-based learning (Kang & Keinonen, 2018).

Because of the above, Kang and Keinonen (2018) noted that the use of learner-centered teaching and learning approaches improves learners' development of basic science concepts. Most important to the development of scientific knowledge and skills of children is the use of learners' everyday lives and their surroundings (Mavuru & Ramnarain, 2017; Mavhunga & Kibirige, 2018). Besides, Asheela (2017) noted that teachers at the Foundation Phase level should see their learners as real scientists in action who solve problems using easily accessible resources.

The South African curriculum and literature justify the importance of introducing young children to science, which is always taught in two domains: domain-specific knowledge, and domain-general knowledge or domain-general strategies (Kidman & Casinader, 2017). This study focused on the second domain; which is the domain-general knowledge, referred to as general science, concepts that involve experimental design and evidence evaluation. This domain is effectively taught through an inquiry-based approach which explains the main aim of this study (Kidman & Casinader, 2017). Kidman and Casinader (2017) view inquiry-based learning as a method that requires an intensive knowledge of pedagogy. The domain inquiry involves instructional approach, the degree of teacher direction, and classroom goals (Kidman & Casinader, 2017).

The alignment of these three concepts is considered as important "for development of inquiry literacy in both teachers and learners, as well as differentiation of discipline-specific inquiry" (Kidman & Casinader, 2017:4). In the same vein, Mkimbili, Tiplic and Ødegaard (2017) understand inquiry-based learning as a process of involving learners in developing questions for investigation, designing investigation procedures, collecting and interpreting, drawing conclusions from the data, and communicating findings. According to these scholars, inquiry-based learning needs to adapt to the context of learners (Mavuru & Ramnarain, 2017), hence the teacher needs to understand their schooling contexts (Mkimbili et al., 2017). Thus, the foregoing necessitated this within the socio-cultural theory of Vygotsky's (1978).

1.2 Theoretical background of the study

Constructivist theories view learners are active participants of any learning encounter rather than viewing them as passive learners (Vygotsky, 1978). More Knowledgeable Other (MKO) and the Zone of Proximal Development (ZPD) are the main principles of Vygotsky's theory. MKO represents a person who understands concepts better than the others in the same group and thus, used his or her better ability to enable others to learn. On the other hand, ZPD refers to the variation in what a child can achieve independently and that which he/she can achieve with a skilled person's guidance. According

to Vygotsky's (1978) socio-cultural theory, children learn through social interactions with more knowledgeable ones. Furthermore, it is through cooperative projects that children are exposed to their peers' thinking processes. To this end, Vygotsky noted that successful problem solvers talk themselves through difficult problems, and when children hear this inner speech, they can learn from each other in a social set-up or context.

From these arguments, it could be surmised that Vygotsky's key principles are aligned with the Constructivist Theory principles which speak to how learning should take place, how knowledge should be developed or constructed, and how experiences and social interactions play a role in learning. It is through these discussed views and principles of pedagogy that Vygotsky's theories are regarded as constructivist theories. For this reason, socio-cultural theory, as a theory of learning, underpinned this study. Hence, the importance of taking into consideration learners' socio-cultural backgrounds and culturally responsive pedagogies have been emphasized (Mavuru & Ramnarain, 2017; Mhakure & Otulaja, 2017).

1.3 Review of related empirical studies

Lazonder and Harmsen (2016) reported that consistent research has shown that inquiry-based learning can be more effective in teaching and learning science than any other instructional approach so long the students are supported adequately. Psycharis (2016) indicated that teachers' scientific abilities rubrics, to a great extent, determine their development of the inquiry-based approach. Inquiry-based instruction improves students' achievement and engagement in the learning of science (Marshall et al., 2017). A study showed that students spent significantly more time on tasks and as well use more relevant scientific terms when their teacher adopts the use of an inquiry-based approach (Gillies & Baffour, 2017). The inquiry-based approach implemented within the use of local languages and culture has the potential to improve learning (Babaci-WilHITE, 2017). Kang and Keinonen (2017) revealed that teachers' use of inquiry-based learning improves students' science achievements. Even though the inquiry-based approach is effective in improving science learning, most teachers face the challenge of adopting a learner-centered approach (Maass et al., 2017). A study by Kang and Keinonen (2017) showed that inquiry-based learning experiences significantly predicted students' science career aspirations positively.

Despite the fact that teachers have a positive belief towards inquiry-based learning, they are less inclined to implement inquiry-based learning in their lessons by claiming that the implementation of inquiry-based learning is faced with a lot of difficulties (Ramnarain & Hlatswayo, 2018). Kang and Keinonen (2018) revealed that the inquiry-based learning approach has a strong positive relationship with students' achievement and interest in science subjects. Kotuláková (2019) found that teachers can provide a stimulating environment for learning science through the use of an inquiry-based approach to enable the students to have basic knowledge which they individually construct. According to Suárez et al. (2018), an inquiry-based approach to teaching and learning is an effective approach for fostering learners' curiosity and motivation in science. McGrath and Hughes (2018) indicated that the use of an inquiry-based approach enhanced the acquisition of basic science concepts by students with learning disabilities. Teachers' effective use of inquiry-based activities leads to high frequencies of experiencing inquiry like science activities by the learners (Chi et al., 2018).

Learners through inquiry-based science pedagogies form successful interaction rituals necessary for their science engagement (Wilmes & Siry, 2018). Uiterwijk-Luijk et al. (2019) found that teachers' use of an inquiry-based approach had a significantly positive relationship with students' curiosity. For science learning, teachers play important roles in inquiry teaching at the foundation phase (Herranen & Aksela, 2019). Teachers' sufficient ability to develop lesson plans, working groups and peer support are determining factors in the readiness of teachers to adopt an inquiry-based science learning

process in the Foundation Phase (Budiastra et al., 2019). Frequent usage of inquiry-based instruction by teachers determines Learners' performance in science examinations (Jerrim et al., 2020). The inquiry-based classroom is significantly effective in improving students' conceptual understanding of science concepts (Tan et al., 2020). Yang et al. (2020) revealed that students' science learning outcomes are enhanced by inquiry-based science teaching.

Gaps in literature

The foregoing has presented enough empirical evidence of the effectiveness of the inquiry-based approach to the development of basic scientific concepts among learners. The review has presented the level of implementation of the inquiry-based approach in schools as well as the challenges inherent in such implementation. Despite that, the teachers surveyed in other African countries and beyond seemed to have a low level of implementation of the inquiry-based approach for science instruction. No empirical study was found in the South African context on the subject matter. Based on these established gaps, the researchers deemed it necessary to explore Grade 3 teachers' use of an inquiry-based approach to mediate the development of basic science concepts among learners.

2. Research method

2.1 Research design

A case study research design of the qualitative approach was adopted for the study. In the same vein, Cohen, Manion, and Morrison (2018) argue that a case study focuses on practice, intervention and interpretation to improve a situation. This design has been used by Thwala et al. (2020), Njemanze et al. (2020), Kgothule et al. (2021), Ntseto et al. (2021) Baloyi-Mothibeli et al. (2021), Thwala et al. (2021) in similar studies.

2.2 Participants

Four (4) Grade 3 foundation phase teachers who were purposively sampled from four different schools in Sarah Baartman District, in the Eastern Cape Province in South Africa, participated in this research. The researchers used purposive sampling to select these teachers because all four teachers were teaching in public, historically disadvantaged schools in quintile 3 and 4. Despite quintile 3 and 4 schools belonging to the previously disadvantaged category, they are not as economically disadvantaged as quintiles 1 and 2 schools. These quintiles determine the school environment, the school set-up, and the money allocation per learner from the government. Besides, the four teachers have witnessed the various curriculum changes in their career of foundation phase teaching. Most relevant of all, these are all female *IsiXhosa* speaking teachers who have also been part of both developmental and professional programmes and have been trained as foundation phase teachers.

2.3 Instruments for data collection

A semi-structured interview guide and observational checklist were used for data collection purposes. These instruments were face validated by experts in qualitative research to ensure that they provide the necessary data as expected. Examples of the interview items include: *As a Grade 3 teacher, what do you understand by inquiry-based approach? Briefly explain how you use inquiry-based approach to enhance learners' development of basic science concepts.* To ensure the trustworthiness of the instruments, they were pilot tested on equivalent subjects outside the scope of the study.

2.4 Procedure for data collection

The researchers paid visits to the participants in their respective schools to conduct individual interviews for the research. The individual interview lasted for about 20-30 minutes. Moreover, the observation schedule was used to observe each of the teachers for about 20 minutes of teaching with respect to the adoption of the inquiry-based approach in teaching basic science. Participants' observation was carried out by the researchers accordingly.

2.5 Ethical considerations

Research Ethical Committee of Rhodes University's Faculty of Education through the Education Higher Degrees Committee granted ethical approval for the conduct of this research. Furthermore, the district, school principals and teachers involved were formally requested and engaged with regards to the conducting of this research. All participants in this study were made aware of the research process through the signing of informed consent forms. This ensured the relationship between the participants and the researcher was strengthened and transparent. The participants were assured of the confidentiality and professional handling of the information they provided. Although the research focus was not on learners, it was important to engage with their parents as the observed lessons were video recorded.

2.6 Data analysis

The qualitative data collected were analysed using thematic data analysis. To achieve that, the researchers wrote narrative stories from all the participants' responses. This assisted the researchers by enabling a bird's eye view of the data collected. This strategy of writing narrative stories from the data was a method of making sense of the data from both interviews and observed lessons. The stories were then analysed into categories and themes arising from the data. Lastly, the raw data from the video-recorded lessons, observations and stimulated recall interviews and group reflections, were used to understand the events that took place when the participants taught in their classrooms and to understand their thoughts of their experiences of inquiry-based approach.

3. Results

The findings were presented in line with the major themes that emerged from the thematic data analysis. In the presentation of these findings; T1, T2, T3 and T4 have been used to represent the four teachers who participated in the study.

3.1 Theme 1: Participants' understanding of an inquiry-based approach

Concerning the participants' understanding of the inquiry-based approach, the following extracts were arrived at from the analysis of their responses:

T1 had the following to say: "It is all about finding out about specific objects. It is about observing, analyzing. So, in my understanding, it is when learners are given the opportunity to make sense of what they are learning by engaging in physical activities and real experiences". T2 had following expressions for her understanding of inquiry-based approach: "Learners are asked to find out about the given topic, for example growing a bean. Visiting museums to explore and to observe those things that we do not have in my school". T3 said: "It is a task-based process and it prepares and develops science knowledge step by step. The teacher explains instructions and activities as learners are working. Teacher sets questions to be answered". T4 said: "It is about asking

questions, solving a problem, discovery learning and engaging on practical activities or being hands-on”.

The four participants had to explain and give their perspectives of a scientific inquiry approach. In their explanations, they highlighted that an inquiry-based approach is about finding out about objects and asking questions (T1, T2, T3 & T4). T1 further explained that observation and analysis are part of an inquiry approach. T2 went on saying that visiting the museum assisted her to make those things that were not visible to her learners, visible. For T4, an inquiry-based approach is about solving problems, discovery learning, and doing practical activities with learners. In support of T4, T2 stated that the use of learners' senses is important during an inquiry approach. In agreement, T1 also noted the importance of physical activities when using an inquiry approach:

3.2 Theme 2: Teachers' perspectives on the use of an inquiry-based approach in teaching basic science concepts in the foundation phase

The following are the views of the participants on the use of the inquiry-based approach in teaching basic science concepts.

T1 said: “inquiry-based approach enables the learners to make sense of what they are learning; Learners to be engaged in physical activities; Learners need to have real experiences; and Learners need to use their senses”. T2 said: “In inquiry-based approach, both the teacher and learners prepare the tasks of instructions and questions, practical activities; and Learners observe, answer questions, while learners' scientific knowledge is developed”. T3 said: “It allows learners to find their own answers; Learners to use their senses; it makes the invisible visible; To conclude findings and can be done inside and outside the classroom”. T4 said: “It starts from home with what the learners know; Learners' experiences; Using textbooks as a supporting resource, and It is about problem-solving”.

Regarding the above extracts, all participants indicated the importance of drawing from learners' experiences while using an inquiry approach and doing investigations in their teaching practice. Besides, these teachers also raised the issue of using learners' senses and making sure that learners are active participants in the lesson. T1 implemented it during her lessons which were observed by the researchers.

4. Discussions

This study has established the fact that teachers' use of the inquiry-based approach is very important in mediating the development of basic science concepts in the Foundation Phase. Despite that the participants had a good understanding of the demands of the inquiry-based approach, the classroom lessons observation data gathered from the four teachers revealed that there are differences when it comes to the implementation of the inquiry-based approach. It was found that only T1, in all her three lessons, created a space for both her and the learners to discuss the task before doing it. This resulted in her learners being part of the lesson, engaging in the asking of questions, and contributing to the design of the investigative questions for the practical investigations across the three observed lessons. On the other hand; T2, T3 and T4 did not implement the same strategy as T1 in their lessons. In all their observed lessons, they were the ones coming up with instructions, and they gave these instructions to the learners without including their perspectives in the design of the activity. Moreover, to introduce their lessons and to make sure learners understood the activities, they often used a question and answer method. The outcome of this study is similar to related empirical

studies by Ramnarain and Hlatswayo (2018), Kang and Keinonen (2018), Suárez et al. (2018), McGrath and Hughes (2018), Chi et al. (2018), Wilmes and Siry (2018), Kotuláková (2019), Uiterwijk-Luijk et al. (2019), Herranen and Aksela (2019), Budiastara et al. (2019), Jerrim et al. (2020), Tan et al. (2020), Yang et al. (2020).

Ramnarain and Hlatswayo (2018) revealed that teachers are less inclined to the implementation of inquiry-based learning in their lessons due to some implementation challenges. The inquiry-based learning approach has a strong positive relationship with students' achievement and interest in science subjects (Kang & Keinonen, 2018). According to Suárez et al. (2018), an inquiry-based approach is an effective approach for fostering curiosity and motivation in science learning by the learners. McGrath and Hughes (2018) indicated that the use of an inquiry-based approach enhanced the acquisition of basic science concepts by students with learning disabilities. Teachers' effective use of inquiry-based activities leads to students' high frequencies of experiencing 'inquiry-like' science activities (Chi et al., 2018). Inquiry-based science pedagogies help students to form successful interaction rituals necessary for their science engagement (Wilmes & Siry, 2018).

Kotuláková (2019) found that teachers' use of an inquiry-based approach can provide a stimulating environment for students' learning of science. Uiterwijk-Luijk et al. (2019) found that students' curiosity relates positively with teachers' use of an inquiry-based approach. For science learning through inquiry teaching at the foundation phase teachers play important roles (Herranen & Aksela, 2019). Teachers' sufficient ability to develop lesson plans, working groups and peer support are determining factors to the readiness of teachers to adopt an inquiry-based science learning process in the foundation phase (Budiastara et al., 2019). Teachers' frequent usage of inquiry-based instruction enhances learners' performance in science examinations (Jerrim et al., 2020). The inquiry-based classroom is significantly effective in improving students' conceptual understanding of science concepts (Tan et al., 2020). Yang et al. (2020) revealed that learners' science learning outcomes are dependent on teacher professional development on inquiry-based science teaching is beneficial to the.

4.1 Strength of the study

In this research, the researchers' focus was on the Foundation Phase level. As alluded to earlier, this research focused on the development of basic science concepts using an inquiry-based approach. This area of focus constituted a new contribution to research in the field of science education as it shifted the science focus from the secondary school level to foundation phase or primary science teaching and learning. In the South African context, there is minimal research in this field as more attention has been given to numeracy and languages (literacy). To make the teaching and learning of science more explicit in the Foundation Phase will prevent the fear that is attached to learning science in secondary schools or higher grades. Since there is very little research on this in the South African context, in particular, the foundational science, knowledge embedded in the beginning of the life skills subject has become a hindrance or constraint in fulfilling the curriculum aims that talks to producing citizens who are creative thinkers. The researchers vehemently argue that there is a need for a shift in mindsets in terms of teaching science in the Foundation Phase and in particular using an inquiry-based approach to develop basic science concepts.

4.2 Limitations

It should be acknowledged that every research study has its strengths and limitations. This study is no exception. This study was conducted in the Sarah Baartman District in the Eastern Cape Province in South Africa. It was conducted with four teachers from four schools. It was recognised that the culture of the four participants and four schools did not represent the whole population of the

Foundation Phase in the Sarah Baartman District and South African teachers in general. Consequently, caution should be exercised in generalizing the findings of this study. Thus, there is a need for further research on the subject matter using a larger sample size.

5. Conclusions and recommendations

This study has established the fact that despite the foundation phase teachers used for this study are aware of the importance of the use of the inquiry-based approach in mediating the development of basic science concepts by the learners, only one out of the four participants implemented it. This is an indication that most of the foundation phase teachers do not know how to implement the inquiry-based approach to enhance learners' development of basic science concepts. Based on the above, the researchers recommended thus:

- There is a need to have in-depth lesson observations on the teaching of science-related topics in the Foundation Phase and across all quintiles.
- There is a need for continuing professional development or professional learning communities for Foundation Phase teachers so that they are supported on how to promote basic science concepts using an inquiry-based approach.

Acknowledgement

The researchers wish to appreciate all the participants as well as the headteachers and parents of the learners who participated in this study for their cooperation throughout the conduct of the study.

Declaration of Conflict of Interest

The researchers have no conflict of interest to declare.

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