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Integrating isiXhosa with Inquiry-Based Learning to Develop Scientific Skills in Early Childhood Development Classrooms: towards Teacher Professional Development

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Abstract. This study focused on developing scientific skills through integrating one South African home language, isiXhosa and an inquiry-based approach in early childhood development (ECD) classrooms. At this level, science teaching in the Life Skills curriculum focuses more on developing scientific skills. Therefore, the article discusses the notion that language is essential to enhance classroom learning. It has been argued that there is a need to consider ways and methods with which science can be made accessible and relevant to all levels of learners across the schooling system. Underpinned by sociocultural theory, this qualitative interpretive case study responds to how using learners' Indigenous language and an inquiry-based approach mediates the learning of scientific skills in ECD. The study purposively sampled two ECD teachers as cases for this paper, as part of a more extensive study from which this article is drawn. Data was collected through interviews and lesson observation and thematically analysed. Findings revealed that integrating the learner's home language with inquiry-based learning is a key pedagogical approach in ECD science instruction, encouraging creativity, cultivating critical thinkers, and creating a solid academic foundation in a supportive, non-threatening environment for future success in complex concepts in later grades. Consequently, the study concludes that young children learn best through their home language, and making any learning experience relevant to their context is

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vital. Thus, teachers in ECD classrooms should be professionally developed to implement the teaching and learning of science-related topics and scientific skills using learners' Indigenous languages.

Keywords: early childhood development (ECD); Indigenous languages, inquiry-based approach; Life Skills; scientific skills

1. Introduction

Early Childhood Development (ECD) is a phase in which a child develops holistically, including physically, cognitively, socially and emotionally (Sakellariou & Banou, 2020). This is a stage where the child's growth domains are critical. Budiharjo (2017) attests that ECD is a crucial phase in a child's growth, earning the referral of being the 'golden period' that happens once and cannot be postponed. The United Nations International Children's Emergency Fund (UNICEF, 2017) emphasises that this phase is significant in a child's development and life as the nervous system develops at breakneck speed every second, a process that cannot be repeated. Therefore, this is a window period that is central to determining and influencing a child's overall trajectory in the future (UNICEF, 2017).

As such, the educational settings in ECD classrooms require both indoor and outdoor activities to stimulate the growth of the child holistically (Cheruiyot, 2024). The responsibilities of teachers at the ECD level are multilayered and encompass more than just teaching. It entails moulding young minds and fostering a passion for learning that will last a lifetime. Therefore, teachers in early childhood classrooms need to continuously engage in transformative pedagogies, which constitute their professional development in their craft to enhance learner performance (Press et al., 2020; Rio & Newman, 2022). As such, teaching requires adaptive practices for optimum growth and achievement of the diversity learners bring to the classroom (Fromberg, 2015). This calls for pedagogies tailored to create an engaging learning setting in multiple disciplines in the ECD classrooms (Darling-Hammond et al., 2020). Hence, there is a need for professional development programmes, termed by Ngcoza and Southwood (2019) as webs of development, to enhance effective teacher pedagogies and the collaborative growth of teachers.

In the ever-evolving world of knowledge, ECD is an essential learning phase where the foundations for mastering language and scientific skills set the basis for a lifetime of learning, adaptation and growth for the learners. The justification for integrating a native language, isiXhosa and employing an inquiry-based approach is multifaceted. From one perspective, this article discusses the promotion of children's Indigenous languages—interchangeably referred to as the learner's mother tongue, home language, native language, or first language, specifically isiXhosa—as the language of teaching and learning (LoLT) in ECD classrooms. The South African government recognised in 1994 the importance of mother tongue instruction in ECD classes and created an educational language policy that raised the status of Indigenous languages, emphasising teaching ECD Grades R–3 students in their mother tongue (Moloi, 2007; Phindane, 2015).

Language is an important tool that enhances the acquisition of knowledge as it allows classroom communication to flow efficiently, leading to effective teaching and learning (Charamba, 2020; Matee et al., 2023). Integrating a child's home language, such as isiXhosa, also preserves and celebrates cultural heritage and creates a bridge between the familiar home environment and the classroom setting. Mavuru and Ramnarain (2019) established that learners' home language has the potential to be used as a resource in science classrooms rather than being perceived as a barrier. Language presents man as a social creature who uses language to spread social and cultural ideas and to further knowledge and education (Akintunde & Akuta, 2021). Akintunde and Akuta (2021) established that when subject content is taught in children's Indigenous language (mother tongue), learners develop the confidence to express their views freely and effortlessly.

The second angle is the fundamental principles of the inquiry-based approach that include but are not limited to active participation in learning and an explorative nature associated with the inquisitiveness that characterises young children. A large body of studies on teaching and science education lessons highlights that it is imperative to implement interactive and more interesting techniques for topic instruction to heighten its significance, provoke and maintain pupils' enthusiasm in learning about it, and enhance their output. According to Kidman and Casinader (2017), applying the inquiry-based learning method demands a deeper pedagogical understanding and requires knowledge construction within disciplines and the growth of the learners' capabilities and desire for autonomy. The development of inquiry-based literacy and the variations of discipline-specific inquiry are based on three important ideas, which are the classroom objectives, teaching approach and teacher guidance (Kidman & Casinader, 2017). Correspondingly, Mkimbili et al. (2017) articulate that inquiry-based learning involves learners being involved in developing research questions, following research etiquette, collecting and examining data, deriving conclusions from the examination, and presenting the findings.

To meet the learners' backgrounds, inquiry-based learning should be aligned properly, and as such, the teacher needs to understand the learners' contexts (Mkimbili et al., 2017). According to Pedaste et al. (2015), inquiry-based learning is a teaching approach where students build knowledge by using techniques and procedures akin to those used by practising scientists. Inquiry-based learning, according to scholars, is also a process of identifying new causal relationships through the formulation of hypotheses by the learner and their subsequent testing through observations and/or experiments (Adeyele, 2023).To further elucidate this, Pedaste et al. (2015) emphasise that this instructional approach fosters learner responsibility for uncovering new information and active participation (Sedlacek & Sedova, 2017).

A large body of research has increasingly encouraged the rethinking of pedagogical practices to better meet the required development of learners in the various cultural contexts of ECD classrooms (Nganga et al., 2020; Singh & Bipath, 2024). Nevertheless, the conventional practices employed in ECD classrooms to teach science often fail to unlock the learner's potential (Pakombwele & Tsakeni, 2022). Teachers are, therefore, faced with the challenges of professionally developing themselves with practices that meet the demands of instilling a love of science in the ECD classroom (Qablan, 2019; Mulyana et al., 2020). Integrating Indigenous languages, also known as mother tongues, such as isiXhosa, with inquiry-based learning to develop scientific skills in ECD classrooms is one of the contemporary approaches that is gaining acclaim (Cekiso et al., 2019). Recognising the significance of cultural and linguistic diversity and children's explorative, questioning, and discovering minds, this initiative aims to create an inclusive and culturally relevant learning environment that enhances scientific literacy and nurtures a strong sense of identity and belonging among young learners (Moore et al., 2018).

This article explores a novel approach to fostering scientific skills in early childhood classrooms by integrating the Indigenous language, isiXhosa, with an inquiry-based approach. This article further explores the theoretical fundamentals that advocate the integration of isiXhosa and an inquiry-based approach, mined from literature based on linguistics, early childhood education, and cognitive science. It also delves into the practicality through examples of classroom case studies where effective implementation of the integrated approach has been applied, sharing insights on the experiences and effects it has on the development of learners' young minds. As it examines the theoretical foundations and the pragmatic scenarios, this article aims to provide educators, policymakers, and researchers with effective culturally responsive practices that could enhance the scientific skills needed in early childhood education.

Research Questions

For this article, there were two research questions.

- What are ECD teachers' understanding of science, basic scientific process skills and an inquiry-based approach?
- How do ECD teachers mediate the development of basic scientific process skills through integrating an inquiry-based approach and isiXhosa home language in their classrooms?

2. Theoretical Framework

Vygotsky's sociocultural theory (1978) emphasises that learning is naturally a social process influenced by cultural contexts and interpersonal interactions. It challenges the notion of learning as an individual cognitive process by highlighting the role of social interaction in cognitive development. In this article, the theory presents three key concepts critical to understanding how learners acquire knowledge in learning.

The zone of proximal development (ZPD) is the range between what a learner can do independently and what they can achieve with guidance from a more knowledgeable other, in this case, a teacher or peer. Learning occurs most effectively within this zone, as learners are stretched beyond their comfort zone while receiving support from teachers or other learners (Vygotsky, 1978). In addition, scaffolding refers to the temporary support that teachers or peers provide to help learners complete tasks they cannot initially perform alone. As learners gain proficiency, the support is gradually removed, fostering independence and mastery of skills. Lastly, learning is mediated through tools and symbols, particularly language. Vygotsky (1978) views language as a primary tool for cognitive development, enabling communication, problem-solving, and meaning making in social interactions.

In this study, Vygotsky's principles were relevant as they align with the inquiry-based learning approach, where students engage in exploration, questioning, and collaborative problem-solving rather than passively receiving information. This approach promotes active engagement, critical thinking and hands-on learning, fundamental aspects of a sociocultural learning environment. Consequently, the study investigated how teachers integrate isiXhosa with inquiry-based learning to develop scientific skills in ECD classrooms.

Learning in early childhood education is socially constructed, requiring structured interactions between teachers and learners. Teachers' use of scaffolding and mediation through Indigenous languages (isiXhosa) is crucial in helping learners grasp foundational scientific concepts. The ZPD framework informs how teachers differentiate instruction, providing varying levels of support to learners at different developmental stages. Furthermore, the study seeks to understand how the cultural and linguistic contexts influence teaching strategies, particularly in under-resourced township schools.

3. Research Methodology

This paper is part of an extensive study that was conducted. The sections below outline the methodologies employed in collecting data to respond to the two questions specified for this paper.

3.1 Research Approach

The study employed a qualitative research approach. Pulè et al. (2021) indicate that qualitative research is a type of scientific inquiry that aims to comprehend a specific issue from the perspectives of those being examined. Merriam and Grenier (2019) further add that qualitative research aims to gather in-depth descriptive data on a particular phenomenon for a specific setting to gain knowledge related to what the study seeks to achieve. Qualitative research suited the study as it focused on the how and why rather than the what of the teaching process to build learners' scientific skills in ECD classrooms (Ugwu & Eze, 2023).

3.2 Research Design

The study adopted an interpretive case study design. The research objective was, as Coombs (2022) specifies, a case study to produce a thorough comprehension of the phenomenon of how teachers integrate the inquiry approach and the Indigenous language isiXhosa into their natural classroom environments when imparting scientific knowledge and skills to their learners (Christiansen & Bertram, 2019). The study drew on the actual experiences of the teachers as sense-producing agents in their daily lives (Ugwu & Eze, 2023).

3.4 Sampling Strategy

The paper is part of a more extensive study from which it is drawn. Focusing on grade 3, a grade that is part of the ECD classes in the South African context, two teachers from the pool of four participants were purposively selected for this paper (Bertram & Christiansen, 2019). The reason for sampling two teachers for this study is that each teacher was explored comprehensively as a case, both in interviews and classroom or lesson observations. The two teachers were sampled from two public, historically disadvantaged township schools categorised as quintile four in the South African context. Both teachers used isiXhosa as a language of teaching and learning in their classrooms. In each classroom, there were about 40 learners, both boys and girls.

3.5 Data Collection Methods

The study used semi-structured interviews and lesson observations as data collection tools. The participants were individually interviewed, varying from one hour to an hour and a half, with two lessons observed from each, to gain in-depth insights into their views, thoughts and experiences in teaching science in early childhood classrooms (Puttick, 2022). The primary objective was to explore the nuanced perspectives of the ECD teachers regarding science education, with a particular emphasis on shedding light on the intricate dynamics of integrating the native language, isiXhosa, and an inquiry-based approach in early childhood settings.

3.6 Data Analysis

Using thematic analysis, data was analysed following the steps of familiarising yourself with the data, identifying, interpreting, assigning, and grouping the codes, themes were developed (Creswell et al., 2016; Dawadi, 2021; Leedy & Ormrod, 2020). The semi-structured interviews were recorded and transcribed, and the observed lessons were videotaped. These instruments provided material for insights into the two teachers' natural teaching environments. Thematic episodes were developed from the narrative stories (Bateman, 2022), which assisted in the analysis process.

3.7 Trustworthiness of the Study

To ensure the trustworthiness of this study, the research followed the principles of credibility, dependability, confirmability, and transferability (Lincoln & Guba, 1985). Semi-structured interviews (tape-recorded), classroom observations (video-recorded), and stimulated recall interviews ensured data triangulation, enhancing the accuracy and depth of the findings. Classroom observations provided insight into how teachers integrated isiXhosa and inquiry-based learning when teaching scientific process skills. The research employed a systematic data collection process, where interviews, observations, and video recordings were carefully documented. Including video-recorded lessons and verbatim transcripts minimised researcher bias and ensured that findings were rooted in participants' actual classroom experiences. Reflexivity was maintained to uphold objectivity in data interpretation. Lastly, the study provides thick descriptions of classroom contexts, teaching strategies, and language integration, making the findings applicable to similar early childhood education settings where inquiry-based learning and mother-tongue instruction are used.

3.8 Ethical Considerations

The ethical process was considered for this study. According to Šimůnková and Šimůnek (2023), research participants are subjects rather than objects of study and must thus be respected. Despite providing their informed agreement, the participants were assured that the research was voluntary and that they might withdraw at any moment. Khoa et al. (2023) establish that researchers need to establish a good rapport with participants because this may occasionally be complicated, impact research tools, and harm other aspects. Therefore, this research study was conducted with formal requests and engagements from the Rhodes University ethics clearance number (2017.04 1 01). The district, school principals, participating teachers, and learners' parents. The research procedure was explained to each participant in this study, and the participants and the researchers periodically reflected on it. This ensured the participants and researchers had a more open and solid interaction. Engaging with the parents was crucial because the observed lessons would be videotaped, as the research focus was on lessons presented to learners.

4. Presentation of Findings

For this article, there were two research questions, and the themes are presented according to the questions.

4.1 What Are the ECD Teachers' Understanding of Science, Basic Scientific Process Skills, and an Inquiry-based Approach?

Research question 1 of this study was based on semi-structured interviews, which allowed researchers to capture participants' perspectives directly, allowing for a more authentic representation of their thoughts, feelings, and experiences (Jaffey & Ashwin, 2022).

4.1.1 Participants' understanding of science teaching in early childhood

The two teachers (T1 & T2) had similar perspectives about science teaching at this level. When asked about her understanding of science during the interview, T1 explained that the term 'science' in the South African curriculum is not used at this level. She commented that the term 'theme' makes better sense. As she explained, at the level of ECD (also known as Foundation Phase in South Africa), using the word science becomes complex and abstract, triggering laboratories and experiments in their minds as teachers. To reach the level of the young minds, she explained that in the South African curriculum, they use the term 'science' in a simple form by focusing on the themes they cover in the Life Skills subject, and science comes out of the themes and activities conducted. In her own words, she stated:

> *"It is difficult to say because once you use the word 'science,' I think of the laboratory and experiments. In Foundation Phase (ECD) we do not use the word science, we use themes. These themes have a scientific angle."*

T2 concurred with T1 that science helps students comprehend the world they live in. She explained that science enables students to conduct experiments and make observations. T2 agreed that scientific instruction should begin in grade R and be practical. She also stated that science should be taught at the basic level to give students a solid foundation and prepare them for high school. The two participants (T1 & T2) also mentioned that teachers should impart fundamental knowledge in the FP so that students can comprehend the problematic ideas taught in higher grades. T1 additionally noted:

> *"Learners at this level like to be hands-on, and they are curious to know more. So, science needs to be more exciting for young learners."*

Similarly, T2 further elaborated on the essentiality of science teaching. According to her, learners in this phase have very little science knowledge; therefore, they need teachers to guide and equip them with information. She stated that learners at this level must be engaged in hands-on activities since they are curious to know more:

> *"Science is a subject that needs to be taken seriously and taught in early childhood. Most learners see science as a difficult subject in higher grades because we do not take it seriously at the lower level."*

T1 and T2 noted that learners can develop their critical and creative thinking skills through science instruction. However, the scaffolding in presenting science needs to be acknowledged, as such a build-up removes the abstractness in the science field. The participants believed that when science is taught well, it helps students think and learn. Higher education is built on the foundation of science. Once more, educators must possess the fundamental knowledge they need to teach their students. T1 also provided examples of ensuring science is covered in her class. She reaffirmed that most are related to science, even though they fall under the Life Skills Curriculum's Beginning Knowledge section. She concluded that fundamental scientific process skills and topic understanding are essential for advancing science.

4.1.2 Participants' understanding of basic scientific process skills

T1 pointed out that identifying and using real-life experiences is a component of fundamental scientific process skills. She explained in her interview that basic scientific process skills involve experiments and investigations in which students make predictions, document, and observe. In addition, students might refine their concepts and consider a particular study or experiment. T2 characterised basic scientific process skills such as experimenting, discovering and finding answers, consistent with this knowledge. Again, during the interview, T2 narrated:

> *"It is about observation, making sure that learners do observe what you teach them."*

In addition, T1 provided real-world examples of how she helps her students learn the fundamentals of the scientific process. She gave an example of how she recently taught about food, explaining to learners what food processing is and how it is done. She described with assurance how she used a DVD on wheat processing, as she calls it: "*Ingqolowa (wheat)*."

T1 claimed that in her class, these process skills are developed through hands-on exercises or experiments. She also mentioned that she lets her students talk about the lessons they have learned. She encourages participation from her students by using the question-and-answer format. She used an example of a dough experiment she conducted with her students. She had groups of learners who prepared bread using various components. In one group, she had bread flour, warm water, yeast, and salt; in another, she had bread flour, warm water, and no yeast. While the third group used cold water, they still had the same ingredients as the first group. During this process, the groups compared the outcomes and then discussed their findings. T1 explained her fundamental scientific process skills while sharing her teaching experiences with them.

Basic scientific process skills, according to T2, are abilities that can expose students to various experiences, such as discussing topics, characterising objects, and elucidating their observations. T2 asserts that letting each student use their senses enables them to acquire fundamental scientific process skills. She recognised her duty as a teacher in introducing students to natural items and offering real resources that were appropriate for their level. She went on to say that for students to comprehend the work given to them, they must actively participate. T1 saw the use of basic scientific process abilities as promoting experimentation. She added that going to a science museum helps her in many different areas. She supported her description of scientific process skills with an example lesson that showed how she taught the many types of soil through a hands-on exercise. Students compared the many characteristics of the soil. This necessitated observation, measurement comparison, testing, and communication. According to T1, teachers need to be well informed and confident about the subject they are teaching to accomplish it. To complete these science-related projects, T1 underlined the significance of giving clear instructions.

4.1.3 Participants' understanding of an inquiry-based approach

Both participants had to explain their understanding of the scientific inquiry approach. In their remarks, the two educators underlined that an inquiry-based approach entails learning about objects and posing questions (T1 and T2). T1 continued by emphasising that both observation and analysis are components of an inquiry technique. T2 went on to explain that going to the museum enables her to produce materials that her pupils are unable to view. T2 supported this by stating that using students' senses is necessary for an inquiry-based approach, as they are key elements:

> *"Solving problems, discovery learning, and doing practical activities with learners."*

In agreement, T1 also noted the importance of physical activities when using an inquiry approach: In her understanding:

> *"It is when learners have the opportunity to make sense of what they are learning by engaging in physical activities and real experiences."*

When asked to explain the meaning of physical activities, she emphasised that they involve dealing with various materials that students must get familiar with. She provided an example of how she taught about shapes, making sure to have a variety of forms in front of the students so they could feel the outlines. She said that to make learning practical and accommodating to various learning styles, she provides her students with authentic experiences in her courses that appeal to as many of their senses as possible. Both participants agreed that using an inquiry-based approach enables students to participate in activities and employ their senses actively.

4.2 How Do ECD Teachers Mediate the Development of Basic Scientific Process Skills Through Integrating an Inquiry-based Approach and IsiXhosa Home Language in Their Classrooms?

Research question 2 was based on lesson observation, which allowed the researchers to capture participants' actions, the events in a specific setting, the activities of a specific person, and the concrete interactions of several people (Puttick, 2022). Because the lesson topic was observed, researchers could document participant behaviour, the events in a particular environment, an individual's activities, and the tangible interactions of several people (Puttick, 2022). Classroom observations played an important role in this study, and all lessons were taught in isiXhosa, the home language for the teachers and learners. The two teachers were shown to use inquiry-based learning and isiXhosa as the mother tongue to apply science-related themes to foster the development of fundamental scientific process skills. The researchers observed two classes taught by each teacher (T1 & T2). This section first presents a narrative of the benefits of using isiXhosa in science teaching, followed by the impact of inquiry-based learning on developing scientific skills and the actual classroom activities showing what happened in the classrooms during observations.

4.2.1 Benefits of using isiXhosa in science teaching

Data showed that learners were afforded the opportunity to freely engage in activities using the home language of learners as an instructional tool; as a result, the context of learning was non-threatening for both teachers and learners. Although learning activities could be improved, teachers created social spaces for learners to take part. In addition, the use of learners' environments in the observed lessons made it comfortable for learners to act as young scientists. T1 further highlighted that she uses

> *"…[t]hemes to promote language and numeracy in her class. The integration of these subjects affords her more time to spend on the Life Skills themes."*

4.2.2 Impact of inquiry-based learning on developing scientific skills

Table 1: Summary of teachers' views on an inquiry-based approach and basic scientific process skills

T	**Inquiry-Based Approach**
T1	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	Both the teacher and learners prepare these tasks, with instructions and questions; Practical activities; Learners observe, and answer questions, and learners' scientific knowledge is developed.

According to the participants, an inquiry-based approach enables students to make meaning of their education while participating in hands-on activities and authentic experiences. Through hands-on activities and the expansion of participation, learners are exposed to real-world situations that stimulate as many of their senses as possible, making learning practical and accommodating a variety of learning styles.

4.3 Lesson Observations: Mediation of the Development of Basic Scientific Process Skills Through Integrating an Inquiry-based Approach and IsiXhosa Home Language

T1 - Lesson 1: Fruits (1 hour long)

The first observed lesson focused on fruits and healthy eating. The teacher began her session on the carpet. Following her return home, the teacher, in the learners' mother tongue, isiXhosa, related a narrative about what had transpired the afternoon before, "Something happened", when she forgot to remove her peeled apple from the table. After letting her students speculate or make predictions using isiXhosa, they finally came up with entertaining but incorrect solutions. She urged students to offer solutions for stopping the apple's colour shift. As a result, the lesson's primary focus was:

"How to prevent fruits from changing colour."

The learners and the teacher selected three potential methods to test and determine which would best keep fruits from changing colour. A solution of salt, sugar, and lemon was in their possession. They tested these on three different fruits: apples, bananas, and avocados. For these three fruits, a different fruit was selected by each group to test or work with. The experiments had to wait until the next day, as the teacher specified. The teacher believed the students would obtain accurate and sensible findings if the trials were left overnight. The reflections on the experiment took place the following day. Throughout the lesson, the teacher and the learners worked together and had different roles to play with the support of a chart written in isiXhosa, as illustrated in Figure 1 below, interpreting the inquiry process that was applied in the activities. *From a story to a chemistry science lesson*, that is how we viewed this lesson. The pictures below show the activities that took place in this lesson.

Figure 1: Testing which solution will work best to prevent fruits from changing colour

This lesson showed how scientific knowledge and cognitive development are improved in ECD classrooms by incorporating isiXhosa with inquiry-based learning. The teacher promoted critical thinking and active engagement by employing a well-known story and promoting predictions. Experiential learning was supported by the tangible demonstration of abstract scientific concepts, though not specified at this level, for example, refraining from using terms such as oxidation, etc., through practical experiments using everyday solutions. Better conceptual understanding and cultural relevance were fostered by the intentional use of isiXhosa. This method emphasised the importance of teaching that is sensitive to cultural differences and the necessity of ongoing professional development to apply effective pedagogies.

T1-Lesson 2: Ants (50mn long)

The participant's second lesson covered insects. Her attention was drawn to ants and their dwellings. The day before, she led her students on a tour around the school and beyond, where they observed many anthills with isiXhosa used as the language of teaching and learning. Applying the inquiry approach, integrated with isiXhosa when communicating, learners were urged to examine the forms, sizes, and construction methods of ants' dwellings. The preceding lesson included facts about why ants needed to construct their houses. Students were then instructed to gather various supplies to construct their ant homes. They gathered everything from grass and little rocks to sticks. For this lesson, the teacher asked questions in isiXhosa that connected the previous lesson to the present lesson. This was very helpful in reminding the learners of what happened the previous day.

The main activity of the observed lesson was for learners to build their own ant homes. In doing this, the teacher asked learners to group themselves and design their ant houses on A4 paper. Each group presented their design, using isiXhosa, explaining the materials they would use for their structures. There was an emphasis on naming the materials in isiXhosa, with the teacher writing how the learners named the material on the board, followed by spelling the words. Next, the learners and the teacher went outside the classroom to build their structures. Learners needed to make sure that the structure could withstand the weather conditions and that ants would be able to come in and out to store their food. This lesson was indeed exciting for both the teacher and the learners as it stimulated curiosity and problem-solving through social interactions. The pictures below show the different structures and work done during this lesson.

Figure 2: Structures of anthills

By using a familiar language, the teacher facilitated active participation, cultural relevance and better conceptual understanding. Learners engaged in hands-on activities by designing and constructing ant homes, which promoted creativity, problem-solving and experiential learning. The emphasis on naming materials in isiXhosa supported language development while fostering scientific reasoning and collaborative learning.

T2- Lesson 1: Characteristics of insects (1hr 10min)

This teacher's first lesson focused on insects. She began the class by inquiring about her students' knowledge of insects. Students named the little creatures they knew from their childhood. After defining an insect, the instructor asked the class if they understood. In this session, the instructor primarily focused on helping the students learn the names of different insects, what an insect is, how it differs from other animals, which insects they are familiar with, and what components insect bodies are made of. To assist the students in comprehending the traits of insects and how they vary from other little animals, she used replicas of insects written in the way they are named in isiXhosa. To identify and discuss the characteristics of insects using the models, she made her learners work in groups. To integrate *reading* and *writing*, learners read a story about an ant as a group. The teacher used this story as a vehicle for learners to narrate their own stories of those insects they knew from their homes. Secondly, she individually gave learners a task to match the names of the insects with the correct insects. In this lesson, the teacher made sure, through writing and reading the names of insects on the board, that the lesson promoted language learning while teaching the topic of insects. She made the learners read the words continuously and spell them. She concluded the lesson by recalling and summarising it and asked the learners a few questions to see if they understood.
The pictures below show the activities that took place in this lesson.

Figure 3: Activities of a lesson about insects

The lesson combined inquiry-based learning with isiXhosa to foster language development and improve comprehension of insects. T2 promoted active engagement and cultural relevance through group discussions and the use of well-known insect names in isiXhosa. Through experiential learning and the use of insect replicas and storytelling, students' conceptual knowledge and narrative abilities were developed. Alongside scientific exploration, the lesson promoted literacy development by reinforcing writing and reading skills.

T2-Lesson 2: The life cycle (50min long)

Lesson 2 was about the life cycles of different animals. To start the lesson, the teacher asked questions that drew from the learners' understanding of the term 'life cycle.' She followed this by giving her understanding of the life cycle and an example of human growth. When she gave this example, the learners understood what she meant by the word life cycle. She further showed how learners play hula-hoop, reminding them of how they play this *game*. When children play this game, they move their waste in a circle, and this gives learners a clear understanding of the life cycle. Together, the teacher and the learners demonstrated how to play hula-hoop. She first spoke about animal babies to teach the content on this topic. Whether or not all animals give birth to babies that look the same as them was the second point of discussion on this topic. She continued by using isiXhosa-written posters that showed the different life cycles of animals. She used a butterfly, a frog, a chicken and a dog. The focus of the posters was to teach the content of the different life cycles of animals. Through discussion and engagement, she ensured her learners understood how the life cycle works for animals. To conclude the lesson, the teacher gave learners activities to do individually. These activities were intended to enhance understanding of the topic taught. The pictures below show the activities and the materials used in this lesson.

Figure 4: Activities about life cycle activities

As specified in the data presented from all the lessons observed, the participants' use of the isiXhosa home language and exploration using an inquiry-based teaching approach created space for free engagement for both the teachers and the learners. The engagement, as the data revealed, led to enjoyment of the lesson. The learner's prior knowledge mediated the learner's participation and active involvement in the lesson. The teachers used models, pictures, illustrations and hands-on practical experiments using easily accessible material to strengthen the development of knowledge in scientific concepts and skills. Comprehensive explanations and descriptions in isiXhosa enhanced the logical sequence of developing scientific skills and knowledge for the concepts presented.

5. Discussion of Findings

The study's findings underscore the critical role of effective pedagogy in ECD science education, as the participants acknowledged its importance in fostering creativity and the development of critical thinking skills among young learners. The narratives revealed that teaching science in the early years is about imparting basic scientific knowledge and preparing children for more complex concepts in later grades. This foundation is crucial, as it helps to ensure a smoother transition to higher levels of education and supports future academic success. In line with this, the Life Skills subject emerged as an integral part of science education in ECD classrooms. The participants viewed the integration of Life Skills into science teaching as an approach that makes learning accessible, engaging, and enjoyable for young children. This finding aligns with the perspective that Life Skills education is foundational in shaping learners' cognitive and social development. By integrating science with other subjects, such as language and numeracy, teachers provide an all-encompassing approach that nurtures young minds, helping them develop a broad range of skills. This aligns with the literature that highlights the foundational role of ECD in shaping learners' academic growth. As noted by Blair (2016), the early years of education are critical for setting the groundwork for understanding various subjects. Early childhood education serves as the foundation for future learning, and as the findings suggest, science education at this stage should not be overlooked, as it significantly influences later academic outcomes. The interconnectedness of the Life Skills themes in teaching science, languages and numeracy in the ECD classrooms brings an all-encompassing approach to developing young minds. As such, as argued by the participant's understanding, learners at the ECD level may not know much about science; hence, effective teaching is critical to guiding the acquisition of the knowledge needed for the fundamentals of science skills.

The findings also suggest that learners may not have prior science knowledge at the ECD level, making practical science teaching critical for developing their understanding of fundamental scientific process skills. As the participants noted, teachers at this level need to guide learners carefully, scaffolding their development of scientific thinking and inquiry. This is consistent with Vygotsky's theory of scaffolding and the ZPD, where learners are guided through new learning experiences with appropriate support. The findings indicate that teachers who employ such practices create an environment where students feel supported and encouraged to explore and inquire.

Based on the insights shared by the participants, basic scientific process skills in ECD include but are not limited to, prediction, recording, observing and exploring. The data further revealed that scientific process skills development is experiential and hands-on, encompassing experiments, active observation and investigational activities. The study's findings highlighted the significance of providing students with various experiences, using their senses and completing challenging activities to develop scientific process skills. Sakyi-Hagan and Hanson (2020) attest that young children are naturally curious and learn best through exploration and scientific discoveries that can develop the analytical and self-disciplined skills fundamental to science. The findings accentuated the importance of teacher preparation, task engagement, and clear instructions to apply SPS in early childhood education successfully. Thus, teachers can better align their instruction to create responsive learning environments by using customised teaching strategies that consider the diversity of their ECD students (Mkimbili et al., 2017).

Findings from the data presented further discovered that the participants' understanding of the inquiry-based approach emphasises core elements of exploration and the use of questions. The findings conveyed the significance of inquisitiveness, framing the inquiry-based approach as a process of discovering information about objects through inquiry and questioning. Concurringly, the participants conveyed the idea that the inquiry-based approach involves problem-solving, discovery learning and practical activities, particularly emphasising the importance of engaging learners' senses. The findings stressed the value of physical activities in facilitating a deeper understanding of the subject matter and the use of diverse materials, offering a tangible example of using shapes as teaching aids to enhance the learning experience. Consequently, the participants were aligned in their belief that the inquiry-based approach encourages active learner involvement by incorporating sensory engagement and hands-on tasks, fostering a dynamic and immersive learning environment.

Moreover, the conclusions drawn from the data presented in the study shed light on the teaching methodologies of the participants, enlightening the successful integration of the inquiry-based approach and isiXhosa language, to foster an engaging and effective science education. Mutually, teachers skillfully integrated the isiXhosa home language to create an inclusive and enjoyable learning environment. As Vygotsky's sociocultural theory (1978) established, the findings revealed the significance of social interactions, collaborative learning and the role of social and cultural dimensions and pedagogical factors in the learning process (Guay, 2022). T1's lessons showed how a narrative about healthy eating can be transformed into a practical investigation of insect habitats and a scientific experiment. According to Vygotsky (1978), a material tool, a system of symbols, most notably language, or another person's actions during social interaction can all serve as the source of mediation. In response, T2 concentrated on the traits of insects and the life cycles of animals, placing a strong emphasis on group projects, language integration, and hands-on learning. The effectiveness of the inquiry-based teaching approach is supported by the participants' skillful use of language, incorporation of easily accessible materials, and emphasis on practical activities. This method encouraged the development of scientific knowledge and skills by facilitating a thorough understanding of scientific concepts and encouraging active learner involvement and enjoyment. According to Chun and Cennamo (2022), because instruction in their ZPD corresponds to the next logical step in their ongoing skill development, learners are most responsive to it. Overall, the data emphasised how well isiXhosa language instruction combined with an inquiry-based approach can give students a dynamic and enriching science education experience.

In summary, the findings from this study emphasise the critical role of exploration and sensory engagement in developing scientific skills in early childhood classrooms. The data supports that hands-on, inquiry-based experiences enhance learners' scientific understanding and foster critical thinking skills. Furthermore, the findings reinforce the importance of teacher preparation and task engagement in creating a responsive and supportive learning environment that aligns with the developmental needs of young learners. Through customised teaching strategies, teachers can effectively mediate the learning process, facilitating students' growth in the scientific domain while respecting their cultural and linguistic diversity.

6. Conclusion and Recommendations

The study looked at integrating isiXhosa with inquiry-based learning to develop scientific skills in ECD classrooms and as a pathway towards teacher professional development. The study found how well isiXhosa language instruction combined with an inquiry-based approach can give students a dynamic and enriching science education experience, fostering an engaging and effective development of scientific process skills. The study concludes by advocating an increased emphasis on the importance of such interventions in science teaching in ECD classrooms and positioning the teachers as key elements, necessitating comprehensive teacher professional development to enhance such instructional skills. Thus, the study opens the door for a paradigm shift towards optimising learners' mother tongue languages to mediate the inquiry approach for scientific process skills. The study population was limited, so conducting the study on a bigger scale, with a diverse sample, including an assessment of tailored professional development on culturally responsive inquiry-based science education in ECD, would be beneficial for future research.

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