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Exploring Early Childhood Teachers' Understanding of Foundational Concepts in Physical Science

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Abstract

Teachers are important in promoting student learning, and as such, their foundational knowledge of concepts has been the focus of numerous research studies. While several studies have examined the impact of teachers' content knowledge (CK) on learners' performance, there is a noticeable gap in research specifically targeting early childhood education (ECE). Although there is some emerging research on ECE teachers' Science CK, few studies concentrate on the critical scientific understanding of everyday concepts like floating and sinking, which is fundamental for children at this level. This study explores the Science CK of early childhood teachers regarding the fundamental concepts in physical science in Lesotho. Four ECE teachers were purposely and conveniently selected for interviews, observations, and analysis of their lesson plans on floating and sinking. The findings indicate that teachers' CK is fragmented. While they possess adequate competence in both common content knowledge and horizon content knowledge, their specialized content knowledge is notably limited. For example, some participants were unable to explain why objects of the same size but different materials either float or sink, highlighting the need for deeper conceptual understanding in science teaching. This study contributes to the body of knowledge for early childhood teachers' science content knowledge. Consequently, it recommends that teacher training institutions and the Ministry of Education and Training implement ECD programs that enhance teachers' science CK.

Keywords: Early Childhood Teachers, Physical Science, Science Content Knowledge

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Abstrak

Guru memegang peranan penting dalam mendorong pembelajaran siswa, dan oleh karena itu, pengetahuan dasar mereka tentang konsep-konsep telah menjadi fokus berbagai penelitian. Meskipun beberapa penelitian telah mengkaji dampak Pengetahuan Konten (CK) guru terhadap kinerja siswa, terdapat kesenjangan yang signifikan dalam penelitian yang secara khusus menargetkan pendidikan anak usia dini (PAUD). Meskipun ada beberapa penelitian yang muncul tentang pengetahuan konten sains guru PAUD, sedikit studi yang fokus pada pemahaman ilmiah kritis tentang konsep sehari-hari seperti mengapung dan tenggelam, yang fundamental bagi anak-anak pada tingkat ini. Studi ini mengeksplorasi pengetahuan konten sains guru PAUD terkait konsep dasar dalam ilmu fisika di Lesotho. Empat guru PAUD dipilih secara sengaja dan sukarela untuk wawancara, observasi, dan analisis rencana pembelajaran mereka pada materi mengapung dan tenggelam. Temuan menunjukkan bahwa pengetahuan konten guru bersifat fragmentaris. Meskipun mereka memiliki kompetensi yang memadai dalam pengetahuan konten umum dan pengetahuan konten terkait, pengetahuan konten khusus mereka terbatas secara signifikan. Misalnya, beberapa partisipan tidak dapat menjelaskan mengapa objek dengan ukuran yang sama tetapi bahan yang berbeda dapat mengapung atau tenggelam, yang menunjukan adanya kebutuhan akan pemahaman konseptual yang lebih dalam dalam pengajaran sains. Penelitian ini berkontribusi pada pengembangan pengetahuan tentang pengetahuan konten sains guru PAUD. Oleh karena itu, disarankan agar lembaga pelatihan guru dan Kementerian Pendidikan dan Pelatihan menerapkan program PAUD yang meningkatkan pengetahuan konten sains guru.

Kata Kunci: Guru Pendidikan Anak Usia Dini, Ilmu Fisika, Pengetahuan Konten Sains

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INTRODUCTION

Teachers' content knowledge (CK) is important regarding their pedagogical instruction. Insufficient CK can contribute to teachers' negative attitudes toward science instruction (Nowicki et al., 2013). As such, teachers, as facilitators of knowledge construction, need to develop strong CK to prevent the transmission of scientifically inaccurate information (Bayuni et al., 2018). Having a comprehensive CK is vital to ensure accuracy and consistency when presenting scientific ideas. Despite being part of learners' everyday experiences, floating and sinking remain difficult topics for teaching, as highlighted by Radovanović et al. (2019). According to Kavalari et al. (2014), many pre-school teachers hold misconceptions about these phenomena due to differences in prior exposure, which often results in inadequately designed learning activities. Such misconceptions can confuse learners, particularly when teachers struggle to explain the concept of density, which is the scientific relationship between the density of objects and that of fluids (Zoupidis et al., 2021). To prevent misunderstandings that may hinder learning, pre-school teachers need to understand the forces acting on objects in fluids as part of their CK.

Shulman (1986) describes content CK as the "amount and organization of knowledge within a teacher's mind," stressing that educators should be able to articulate and interpret this knowledge—such as the concepts of floating and sinking—in ways that are meaningful to learners. For effective teaching, it is essential that teachers thoroughly understand the core of the subject matter to make it accessible to students (Keçeci & Zengin, 2017). Similarly, Odumosu et al. (2018) point out a strong link between teachers' CK and learners' academic achievement. Consequently, when teachers lack sufficient CK, it can result in misconceptions, misinterpretations, and misunderstandings being passed on to learners (Ishola & Udofia, 2017).

Early childhood education places a stronger emphasis on play-based, exploratory, and hands-on learning experiences, which differ from the structured and abstract approaches often found in later schooling. Consequently, teachers' science content knowledge in ECE must be understood within these unique pedagogical needs and learning objectives. However, much of the existing research on teachers' science content knowledge (CK) has concentrated on higher education, secondary, and elementary levels. At the same time, relatively little attention has been given to early childhood education. For instance, Tekin et al. (2020) reported that pre-service science teachers demonstrated improved CK and argumentation skills after completing a socio-scientific issues-based course. In Finland, Södervik et al. (2014) found that primary school teachers struggled to provide satisfactory responses to open-ended questions on photosynthesis. Similarly, Kinghorn (2013), in a study conducted in Alabama, Iowa, and Kentucky, identified gaps in CK among elementary and intermediate science teachers. In another study, Catalano et al. (2019) examined the link between teachers' science CK and their self-efficacy, revealing an inverse relationship between teachers' confidence in their ability to teach science effectively and their science belief scores.

Pre-school educators who engage in higher education programs are expected to implement the subject matter and instructional approaches learned during their studies. In many contexts, governments and institutions make substantial investments in teacher development to ensure educators possess both strong CK and solid pedagogical expertise (Darling-Hammond, 2017). Both in-service and pre-service teachers gain formal preparation in CK and pedagogy through teacher education programs, which play a vital role in equipping early childhood educators to fulfill their classroom duties effectively (Waltzer et al., 2023). According to Costa et al. (2023), such training programs aim to strengthen teachers' skills, knowledge, and professional attitudes.

The concepts of floating and sinking are commonly introduced in early childhood education (Radovanović et al., 2019). Research shows that teaching these phenomena to young learners requires engaging with abstract scientific ideas such as density, pressure, buoyancy, and buoyant force (Zoupidis et al., 2021). Misconceptions are frequent, with many children assuming that objects sink solely because they are heavy and float simply because they are light (Kiray et al., 2015). For instance, learners may predict that a large wooden block will sink while a small piece of iron will float (Leuchter et al., 2014). Scientifically, however, whether an object floats or sinks depends on a comparison between its mass and volume relative to the liquid in which it is submerged (Radovanović et al., 2019).

Research on children's understanding of floating and sinking shows that they often assume light, small, flat, or hollow objects will float, while larger and heavier ones are expected to sink (Kiray et al., 2015). Literature also suggests that learners may attribute floating or sinking to the way an object is placed in water. For instance, some believe that an item will float if it enters the water with its sharp edge pointing downward (Kiray et al., 2015; Radovanović et al., 2019). According to Russell-Bowie (2012), teachers who themselves hold misconceptions about such concepts are more likely to spend extended time on these topics, rely heavily on low-level questions, and unintentionally reinforce incorrect ideas. Furthermore, insufficient science content knowledge among teachers increases the risk of conveying inaccurate explanations and perpetuating misconceptions.

The ideas of floating and sinking are linked to both early and advanced stages of learning. Within Early Childhood Development (ECD), the notion of "material type" provides a basic framework that supports children's understanding of density (Zoupidis et al., 2021). As learners progress to higher grades, more complex concepts such as force and matter are introduced to extend this foundation (Qonita et al., 2019). Paik et al. (2017) propose that the idea of force can be incorporated into middle school science, building upon students' earlier encounters with floating and sinking in the lower grades. According to Zoupidis et al. (2021), misconceptions around these phenomena can be corrected by allowing students to observe how objects made of the same material, but differing in mass and volume, exhibit different behaviors in water.

Language serves as a key cognitive tool for children as they construct an understanding of scientific concepts, including phenomena such as floating and sinking (Fazio & Gallagher, 2018). Through cross-curricular integration, learners may, for example, count objects that float or sink, thereby linking science learning with numeracy skills. To ensure children are adequately prepared for formal schooling, pre-school educators need strong science content knowledge and the ability to foster scientific process skills in their learners (Qonita et al., 2019). Campbell and Chealuck (2015) stress that even at the pre-school level, children should begin developing fundamental scientific skills such as observation, classification, comparison, communication, experimentation, and measurement. Additionally, broader competencies—problem-solving, generalization, recording, collaboration, counting, and estimation—should be embedded in science teaching and not neglected (Beaumont, 2010). When preschoolers are provided with opportunities to practice such skills, they tend to show greater engagement and interest in learning (Campbell & Chealuck, 2015). Although young children may not always be conscious of acquiring these abilities, teachers can intentionally nurture them. Educators may highlight specific skills when introducing science concepts; for instance, in lessons on floating and sinking, children might classify objects as floating or sinking, or document their results before making predictions or observations. Such activities integrate a range of processes, including inferring, predicting, experimenting, observing, and drawing conclusions.

A number of studies have investigated how floating and sinking are conceptualized in teaching and learning contexts. Andersson and Gullberg (2014) found that learners frequently hold misconceptions about these phenomena and that classroom activities often fail when teachers provide limited support. Similarly, Radovanović et al. (2019) examined strategies for addressing such misconceptions by comparing active learning with traditional instructional methods, concluding that interactive teaching proved more effective. Zoupidis et al. (2021) explored the didactic transformation of floating and sinking concepts in Grade 5, demonstrating that their approach successfully countered learners’ pre-existing misconceptions. At the pre-school level, Akçay (2016) investigated teachers’ self-perceptions of their competence in teaching science and reported that many educators regard science as abstract and difficult for young children to grasp. This perception may contribute to the reduced time allocated to science activities in early childhood settings (Saçkes et al., 2011), a challenge that may be linked to teachers’ content knowledge.

The theoretical framework for this study is Content Knowledge for Teaching (CKT), developed by Ball et al. (2008) as an extension of Shulman’s (1986) concept of Content Knowledge (CK). According to Etkina et al. (2018), CKT highlights the importance of teachers having a deep understanding of subject matter to effectively respond to students’ learning difficulties and improve their comprehension. In this study, CKT is applied to explore how teachers identify and address students’ understanding of floating and sinking concepts while minimizing common misconceptions (Kiray et al., 2015).

CKT builds upon Subject Matter Knowledge (Content Knowledge) and comprises three subdomains: Common Content Knowledge (CCK), Specialized Content Knowledge (SCK), and Horizon Content Knowledge (HCK). Common Content Knowledge (CCK) refers to the general knowledge acquired by professionals across various fields (Jakobsen et al., 2013). For instance, it is commonly understood that some objects float while others sink in water. Participants were asked to explain the concepts of floating and sinking and how they would teach those concepts to the learners. Specialized Content Knowledge (SCK) pertains to the unique knowledge explicitly required for teaching, which is not necessary in other professions (Zambak & Tyminski, 2017). This includes a teacher’s ability to apply CCK to help students understand unexpected outcomes, such as why certain objects may not behave as anticipated in water. In this case, participants had to describe some basic scientific reasoning regarding the behaviour of objects when immersed in water. Horizon Content Knowledge (HCK) involves recognizing the connections between different topics across the curriculum, enabling teachers to situate specific concepts within a broader educational context (Jakobsen et al., 2013). Participants were expected to elucidate the progression of the concepts in a broader curriculum context.

Although numerous studies have examined science teachers’ content knowledge (CK) across different educational levels (Catalano et al., 2019; Tekin et al., 2020), there has been relatively little research focusing on teachers’ understanding of specific concepts, such as floating and sinking. In particular, early childhood teachers’ science CK remains underexplored. This study, therefore, seeks to investigate early childhood teachers’ CK with regard to floating and sinking concepts. The study is guided by the following research question: What is the CK of Early childhood teachers of the Science concepts floating and sinking in Lesotho?

METHODS

Research Approach

This study followed a qualitative research approach using an interpretivist paradigm because the data were collected in the natural settings of the participants. The idea was to understand participants' lived experiences and their engagement with teaching fundamental science concepts in early childhood. For this study, the concepts of floating and sinking were explored. A case study design grounded in qualitative research methods was employed. This design is suitable for collecting data from teachers at their respective schools (Thanh & Thanh, 2015). The participants were purposively and conveniently sampled to ensure the data would be rich and manageable, allowing for a deeper understanding of their interpretations and practices.

Participants

Four Grade R teachers were purposefully selected. The participants were drawn from a larger PhD study that was conducted in two phases. In the quantitative phase, teachers’ performance was assessed, and for the qualitative phase, a purposive sampling strategy was employed. Specifically, the two highest-performing and the two lowest-performing participants were selected. This selection was made to provide contrasting perspectives and a richer understanding of the phenomenon under study. By including participants at both ends of the performance spectrum, the study aimed to capture the range of teachers' science content knowledge and to explore how varying levels of understanding influence their explanations and classroom practices. In case study research, limitations are observed; nonetheless, the goal is not to generalize statistically but to provide a deep, contextualized understanding of a particular case. All participants were female and possessed the Certificate in Early Childhood Development. They varied in terms of age, teaching experience, and the number of learners in their respective classes. Pseudonyms (Topo, Edith, Shoeshoe, and Sofia) were employed to maintain the confidentiality of both the participants and the research sites.

Data Collection Instruments

While conducting interviews and observations, we used an audio recorder to capture every detail of the participants' views and classroom interactions for data transcription. Each participant's lesson was observed for a week, with each session lasting approximately thirty minutes. A pre-observation interview, which lasted about forty minutes, was conducted a day before the observation, while post-observation interviews were held after each classroom session. To complement the observations and interviews, we analyzed the lesson plans of the four participating teachers. With their permission, we photocopied these lesson plans to use as a reference during data analysis at home. Ethical considerations were meticulously followed in data collection. This included obtaining ethical clearance from the Lesotho, ethical approval from the Lesotho Ministry of Education and Training, and permission from the school principals. Participants were also informed of their rights, and assurances of anonymity and confidentiality were provided.

Data Analysis

The data were analyzed thematically following Braun and Clarke's (2006) thematic analysis. These steps are engaging with data, finding necessary codes, developing emerging themes, evaluating and refining themes, defining and naming themes, and combining findings. The following approach was followed in the process of data analysis: first, the data were transcribed and read multiple times to ensure familiarity. Initial codes were generated inductively from the data, guided by the research questions. These codes were then grouped into categories, which were further refined into themes through an iterative process involving constant comparison across participants' responses. To enhance credibility, the themes were reviewed by the researcher to ensure consistency and alignment with the data. Participants were asked to explain the concepts of floating and sinking and how they could effectively convey these ideas to learners. The analysis procedure was systematic: pre-observation interviews were analyzed first, followed by classroom interactions and the examination of lesson plans. Teachers' Content Knowledge (CK) was evaluated under three domains: Common Content Knowledge (CCK), Specialized Content Knowledge (SCK), and Horizon Content Knowledge (HCK), according to the theoretical framework guiding this study. The guidelines for organizing data in this manner were followed because the CCK data focused on teachers' factual understanding of scientific concepts, with the limitation that responses may reflect recall rather than deep conceptual reasoning. For the SCK, data captured teachers' ability to explain and apply concepts in pedagogical contexts, acknowledging that classroom constraints may influence their responses. For the HCK, data examined teachers' awareness of related concepts and their ability to link topics across the curriculum, with the understanding that this broader knowledge may be unevenly developed. Data coding helped identify patterns and assign themes, which were then used as internal codes for descriptive and narrative analysis.

RESULTS AND DISCUSSION

Teachers' Common Content Knowledge

Teachers' Common Content Knowledge (CCK) was explored using the following categories: (a) knowledge acquisition, (b) comprehension of floating and sinking, and (c) knowledge background.

Knowledge Acquisition

During the interviews, participants shared information regarding their prior exposure to science knowledge, to understand how their high school education and/or teacher training influenced their competence in science concepts. Three participants, Topo, Edith, and Shoeshoe, reported that they had not studied physics or chemistry.

- Topo : "I did Biology in high school…"
- Edith : "…we were doing Human and Social Biology."
- Shoeshoe : "I did Biology."

In contrast, Sofia had studied Physics in addition to Biology and Chemistry, stating, "I did Biology, Chemistry, and Physics." The participants also highlighted that their college-level training had been valuable in equipping them with effective teaching strategies.

Comprehension of Floating and Sinking

Participants were asked to explain their understanding of floating and sinking. All these concepts are associated with the weight of objects. For example, Sofia noted, "Floating are the things that float in water; they float because of their density" (researchers' emphasis). The discussion then explored participants' deeper conceptual understanding. Topo described floating as objects being suspended on the water's surface, a description consistent with Kiray et al. (2015). Edith's understanding was further observed during her classroom interactions, where she explained that an object that does not sink when placed in water is considered floating. Shoeshoe defined sinking as the process by which objects move downward in water, while floating occurs when objects remain on the surface.

Knowledge Background

Research indicates that both practical experience and college-level education contribute to the development of content knowledge by integrating theoretical and practical learning (Kelly & Tannehill, 2012). The participants in this study had substantial teaching experience: Topo with nine years, Edith with ten, Sofia with five, and Shoeshoe with twelve. Their experience suggests that they are capable of linking learners' prior knowledge with new concepts, supporting meaningful learning (Gonzales, 2019).

Teachers' Specialized Content Knowledge

Participants' Specialized Content Knowledge (SCK) was examined through two sub-themes: (a) teachers' explanation of why objects float or sink, and (b) engagement of science process skills.

Teachers' Explanation of Why Objects Float or Sink

We explored participants' Specialized Content Knowledge (SCK) by probing their understanding of why objects float or sink in water. To do this, we asked questions designed to elicit detailed explanations about the principles behind these phenomena. Topo suggested that objects float because they are light, a view echoed by Edith, who added, "Yes, except that they are light, I do not know." This explanation reflects a common misconception, as it oversimplifies the concept by attributing floating solely to an object's weight rather than its density in relation to water.

In contrast, Sofia and Shoeshoe provided scientifically accurate explanations. Sofia articulated that objects float because their density is less than that of water. She explained, "It is because their density is less than water. It is not heavier than water; therefore, the object will not sink in water." This explanation aligns with the scientific principle of buoyancy, where objects with a lower density than the fluid they are in will float, while those with a higher density will sink.

Understanding of Density

When asked to clarify her understanding of density, Sofia explained, "The shape and the materials of the object determine whether the density of the object is less or more." This response reflects her recognition that both an object's physical characteristics and material composition influence its buoyancy. To further probe her understanding, we presented a scenario involving a metal spoon and a metal ship, both made of the same material, and asked why one might sink while the other floats. Sofia attributed the difference solely to the material composition, overlooking the fact that the key factor is the overall density relative to the fluid, which also depends on the object's shape and volume.

In a nutshell, Sofia and Shoeshoe demonstrated a more scientifically accurate understanding of floating and sinking principles, whereas Topo and Edith displayed gaps in their grasp of these fundamental concepts. This variation underscores the importance of strong science content knowledge for teachers to convey scientific ideas to learners accurately.

Engagement of Science Process Skills

Participants were also interviewed about the scientific process skills they aim to develop in learners, and their lesson activities were analyzed to assess their Specialized Content Knowledge (SCK) in fostering these skills. Sofia identified communication and experimentation as the primary skills she would develop, while Topo focused solely on observation. Sofia explained:

> "As they are learning, they will gain communication skills because they will be communicating. Maybe they will get new words from that; they are going to observe; they are going to experiment."

Figure 1 summarizes Sofia's lesson activities, highlighting the scientific skills she planned to engage her learners in.

Activities
1. They will collect materials that are going to float
2. They will classify the sinking objects and the floating objects
3. They will predict what is going to happen to objects
4. They will make experiments about sinking and floating

Figure 1: Sofia's Lesson Activities

In Sofia's planned lesson activities (Figure 1), she outlined that learners would classify, predict, and experiment. However, during the interview, she mentioned focusing on communication, observation, and experimentation. We anticipated that she would encourage learners to discuss floating and sinking objects and observe their behaviour, as she had indicated in the pre-observation interview. Sofia's lesson plan clearly outlined the scientific skills that learners were expected to develop, unlike the other participants, whose activities were less specific and did not always align with their stated objectives.

Teachers' Horizon Content Knowledge

To investigate teachers' HCK, this sub-theme is divided into the following categories: (a) advancement of floating and sinking concepts and (b) teachers' integration of science concepts.

Advancement of Floating and Sinking Concepts

During the exit interview, participants were asked how they would connect the concepts that learners encounter in higher grades. The responses varied. Topo and Shoeshoe mentioned the concept of forces, while Topo also agreed with Sofia that learners would need to learn more about density. Topo elaborated:

> "I think they can learn about the forces so that they understand what causes object to float or sink yet they are made of the same material. They can learn about density."

Shoeshoe was also confident that learners would need to study concepts related to force, stating: "I believe they will learn about force, if I remember correctly." Sofia anticipated that learners would delve deeper into density in higher grades, explaining: "I expect them to learn more about density, such as how some objects, even if they are small, can have a greater density than water." While the concepts of floating and sinking are typically introduced in lower grades, abstract terms like density and buoyancy are commonly addressed in upper grades, as noted by Topo and Sofia. When asked about concepts related to floating and sinking that learners would encounter in higher grades, Edith responded: "I think they should use another method." Her answer did not directly address the question, and upon further probing, she admitted with a laugh that she did not know.

Teachers' Integration of Science Concepts

The data indicate that participants were aware of the integration of concepts across curricula when teaching a specific topic. For example, all participants identified learning areas that could be combined to emphasize the concepts of 'floating and sinking'. However, there was a discrepancy between their interview responses and their lesson plans. Further analysis of their lesson presentations revealed similar inconsistencies. When asked about integrating floating and sinking concepts with other learning areas, Topo responded:

> "I think we can talk about more or less objects in numeracy, big, small objects. In literacy, we can stress the colours and talk about objects' colour. We can even talk of the most dominant sound, like /s/ in stick, stone, and other objects."

Although Topo mentioned that she could incorporate discussions about objects into numeracy and dominant sounds into literacy, her lesson activities did not reflect these integrations. However, her actual lesson presentation did include counting and adding numbers related to floating and sinking objects.

Edith's lesson activities did not align with her pre-observation interview statements about counting objects. When asked about integrating floating and sinking concepts with other learning areas, she said: "In numeracy, we can count how many objects are floating and how many are sinking. In literacy, we can name the objects." Despite these assertions, none of Edith's five lesson presentations demonstrated the integration of other learning areas with the focus on 'floating and sinking'. This indicates that while the participant understood the potential for cross-curricular integration, it was not evident in her planning or lesson execution.

Discussion

The key finding of this study is that the Science Content Knowledge (CK) of the participating early childhood teachers in Lesotho is fragmented. This conclusion will be explored in more detail through: (a) the expected Common Content Knowledge (CCK), (b) the limited Specialized Content Knowledge (SCK), and (c) the adequate Horizon Content Knowledge (HCK).

Anticipated General Content Knowledge

The study revealed that participants had the expected Common Content Knowledge (CCK) of the concepts of 'floating and sinking.' All four participants demonstrated adequate CCK, with Sofia appearing to have the most extensive subject matter knowledge. This is likely due to her high school education in Biology, Chemistry, and Physics before pursuing a teaching career. Some of her insights during the interviews may have been influenced by this foundational knowledge. Despite their considerable experience, the participants' understanding of floating and sinking did not significantly impact their interview responses or classroom interactions. This underscores the finding that while pre-school teachers possess the expected CCK, its application in practice may be limited (Zoupidis et al., 2021).

Inadequate Specialized Content Knowledge

The study also found that participants struggled to explain why objects float or sink in water, indicating limited Specialized Content Knowledge (SCK). This limitation became evident when participants were asked to explain why a pin sinks while a boat made of the same metal floats. Sofia, for instance, incorrectly attributed the boat's ability to float to its triangular shape, reflecting a misconception identified by Kiray et al. (2015) that floating and sinking are related to an object's shape. Similarly, Topo believed that a boat floats solely because someone is driving it, demonstrating another misconception. This seems to indicate that teachers may possess formal scientific knowledge but experience difficulties transferring this knowledge into practical teaching contexts. Factors such as reliance on everyday experiences, limited opportunities to connect disciplinary knowledge with pedagogy, and the demands of teaching young children through play-based methods can contribute to these gaps.

Kiray et al. (2015) observed that teachers often believe objects float because they are light and sink because they are heavy. This misconception was evident in the classrooms of the four participants. Scientifically, this explanation is insufficient and contributes to misunderstandings of the concepts of floating and sinking (Zoupidis et al., 2021). Shoeshoe was the only participant who provided a relevant explanation appropriate for the learners' level. When asked why a stone was sinking, a learner correctly noted that it was at the bottom of the water, as seen in the basin. This finding is significant because teachers with limited content knowledge may misinterpret concepts, which can negatively impact young learners. The results signify the need for teachers to have a thorough understanding of the science concepts they teach and to receive professional development that prepares them to handle unexpected questions with confidence (Costa et al., 2023).

Sufficient Horizon Content Knowledge

The findings revealed that participants' horizon content knowledge was generally adequate. Some participants were aware of topics that Early childhood teachers would encounter in higher grades, while others were less informed. The results indicated that participants were capable of linking concepts across curricula, such as understanding that learners would study density and force in higher grades. This ability to connect concepts throughout subjects is consistent with Jakobsen et al.'s (2013) definition of horizon content knowledge. However, one participant, Edith, struggled to relate the concepts of floating and sinking to those taught in higher grades. In contrast, force and matter are recognized as progression concepts for higher grades, and Qonita et al. (2019) suggest that concepts like volume and density can be introduced in upper grades with appropriate instruction. Paik et al. (2017) also support the idea of integrating the concept of force into middle school curricula, particularly in relation to the floating and sinking concepts covered in lower grades, a perspective affirmed by some participants.

The data indicated that participants had some understanding of how to integrate content across curricula. While this integration was evident in certain instances, it was lacking in others. For example, during the pre-observation interviews, all participants described how they would incorporate floating and sinking into various subjects to emphasize their content. However, their actual lesson plans did not align with these initial statements. Specifically, Topo, Edith, and Sofia created lesson activities that did not include the integration of floating and sinking as planned (see Figure 1). Only Shoeshoe's lesson plan was consistent with her initial description. This inconsistency may stem from several factors. First, it could indicate gaps in pedagogical content knowledge, where teachers struggle to translate curriculum intentions into effective classroom strategies. Second, time constraints and classroom management pressures may lead teachers to simplify or abandon planned activities. Third, a lack of confidence in teaching science may cause teachers to default to safer, familiar practices rather than experimenting with hands-on science learning. This finding underscores the importance for curriculum designers, education authorities, and college educators to ensure that teachers are well-equipped with the necessary content knowledge, as it is crucial for effective teaching in every classroom.

CONCLUSION

The primary objective of this study was to assess the Science content knowledge (CK) of early childhood teachers in Lesotho concealed by conducting interviews, observing classroom practices, and analyzing lesson plans. The findings reveal significant aspects of the teachers' CK: the expected Common Content Knowledge (CCK), the limited Specialised Content Knowledge (SCK), and the adequate Horizon Content Knowledge (HCK). These results highlight that teachers' CK is fragmented, a phenomenon not extensively addressed in existing literature, which typically examines these elements separately rather than in combination. This fragmented CK comprises expected, limited, and adequate components that could potentially impact the effectiveness of science instruction. The study concludes that early childhood teachers in Lesotho exhibit limited Science CK.

Considering these findings, the study recommends revising college syllabi to incorporate the essential Science content that teachers will need to teach in schools. This revision should ensure a coherent alignment between the college curriculum and the school curriculum. However, it is important to develop content that addresses the needs of teachers without compromising the needs of the learners. To boost teachers' confidence, the core Science content provided in college should exceed the level they will be teaching.

Furthermore, the findings suggest that early childhood teachers may benefit from additional scientific background during their teacher training. Targeted professional development initiatives are recommended, including workshops focused on hands-on, play-based science teaching, mentoring programs that pair less experienced teachers with those who demonstrate strong science content knowledge, and in-class coaching to support the translation of theory into practice. While having the expected Common Content Knowledge (CCK) is important, it's crucial not to overlook the significance of Specialized Content Knowledge (SCK) and Horizon Content Knowledge (HCK). Weaknesses in any of these areas can undermine teachers' skills and confidence in delivering content. Therefore, this study recommends that all three domains of Content Knowledge —CCK, SCK, and HCK —be given equal attention, as each contributes to effective classroom practice. Enhancing ECD teachers' understanding of science concepts should be a key objective for teacher education programs.

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