THE INFLUENCE OF LESOTHO GRADE R TEACHERS' SCIENCE CONTENT KNOWLEDGE ON THEIR CLASSROOM PRACTICES

by

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Declaration

I, Mamontsuoe Lintle Maraisane declare that the thesis, THE INFLUENCE OF LESOTHO GRADE R TEACHERS' SCIENCE CONTENT KNOWLEDGE ON THEIR CLASSROOM PRACTICES, submitted for the qualification of Doctor of Philosophy in Education at the University of the Free State is my own independent work.

All the references that I have used have been indicated and acknowledged by means of complete references.

I further declare that this work has not previously been submitted by me at another university or faculty for the purpose of obtaining a qualification.

10/11/2020

SIGNED DATE

Abstract

Previous research has identified teachers' knowledge as a strong factor in influencing classroom practice, hence teachers are regarded as the main locus in the education system. Accordingly, a number of studies have focused on teachers' content knowledge and how it shapes learners' performance. The focus has tended to be on higher levels of education, ignoring teachers in early childhood sectors. Despite research on Grade R teachers' science content knowledge (TSCK), little is known about how it influences classroom practices, and vice versa. This is therefore the focus of the study, notably in Lesotho. The study aims to contribute to the existing body of knowledge in Early Childhood Education sector as well as science teaching. Shulman's Teacher Knowledge Framework and Content Knowledge for Teaching (CTK) framework form the framework of this study. A mixed methods approach, based on a sequential explanatory design, was followed, with a survey of 100 Grade R teachers' science content knowledge measured in the first phase to inform the second phase. Four teachers from the main sample were purposely and conveniently selected to be interviewed and observed to participate. The observed and interviewed participants' lesson plans were analysed to add to the credibility of the study**.** Descriptive and inferential statistics were used in quantitative part, while the qualitative interviews, observations and document analysis were used to triangulate qualitative findings. The findings suggest that teachers' CK was fragmented; they had expected common content knowledge, limited specialised content knowledge and adequate horizon content knowledge. The study also found that Grade R teachers' content knowledge had weak or no influence on their classroom practices. In conclusion, it re-affirms the importance of Grade R teachers' science content knowledge and that they may be other factors not discovered by this study that influence their practices. The study recommends that the teacher training institutions and the Ministry of Education and Training organise ECD programmes such that teachers are enriched with content above the level they teach in order to enhance their CK.

Key words

Content knowledge; learner-oriented practices; pedagogical content knowledge; teacher knowledge; teacher-oriented practices

Dedication

I dedicate this thesis to my parents Ramoipone and Malintle Molongoana. You have been pillars of strength and always there for me. You have taught me the values of integrity and human respect. God bless you.

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I cannot leave out the principal of schools to whom I went for classroom observations, or the Grade R teachers who took part in this study.

I am grateful to the Lesotho 2016 and 2017 SANRAL cohort for your help in so many ways to shape my study, and words of encouragement when the going seemed tough. The staff in the department of Early Childhood and Special Education, you helped me in so many ways. Thumbs Up!

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List of Acronyms

ADEC	American Distance Education Consortium
BSc	Bachelor of Science
BSc Ed	Bachelor of Science in Education
CAPS	Curriculum and Assessment Policy Statement
CCK	Common Content Knowledge
CECE	Certificate in Early Childhood Education
CK	Content Knowledge
CKT	Content Knowledge for Teaching
ECD	Early Childhood Development
EFA	Education for All
FPE	Free Primary Education
HCK	Horizon Content Knowledge
IECCD	Integrated Early Childhood Care and Development
KC	Knowledge of Curriculum
KCS	Knowledge of Content and Students
KCT	Knowledge of Content and Teaching
LCE	Lesotho College of Education
LOCP	Learner-Oriented Classroom Practices
MDG	Millennium Development Goals
MoET	Ministry of Education and Training (Lesotho)
NUL	National University of Lesotho
PCK	Pedagogical Content Knowledge
RNCS	Revised National Curriculum Statement
SANRAL	South African National Roads Agency Limited
SAS	Statistical Analysis System
SCK	Specialised Content Knowledge
SD	Standard Deviation
SDG	Sustainable Development Goals

SMART	Specific, Measurable, Achievable, Realistic and Time-Bound
TPCCKSC	Teachers' Perceived Common Content Knowledge on Science Concepts
TPHCK	Teacher Perceived Horizon Content Knowledge
TOCP	Teacher-Oriented Classroom Practices
TPSCKFS	Teachers' Perceived Specialised Content Knowledge on Floating and Sinking
TSCK	Teachers' Science Content Knowledge
UFS	University of the Free State
UN	United Nations

Chapter 1.

BACKGROUND AND ORIENTATION TO THE STUDY

1.1. Introduction

Teachers' knowledge has been recognised as a strong aspect in prompting the improvement of classroom practice and learners' performance, hence they are perceived as the main factors in changing the education system (Anderson, 2015; Deniz & Adibelli, 2015; Diamond et al., 2013; Friedrichsen et al., 2011). The ability and competence to impart this knowledge, along with attitudes, skills and values, qualifies a teacher to be a quality teacher (Spaull, 2013). It is expected that teachers will interact with learners and the intended content during classroom practice (Maboya, 2014), so having appropriate knowledge is an essential requirement in the classroom. If they understand a topic's content they will impart its sub-topic to the learners with ease. For example, of significance to the focus of this thesis is that adequate comprehension of science content is translated into effective science classroom practice (Abd-El-Khalick, 2012).

The concept of knowledge is explained by Jiménez-Aleixandre and Erduran (2007) as that which "lives" within a set of individuals, from all spheres of life and class, for instance, a group of researchers or scientific scholars, or a community of teachers. The group's knowledge can be limited to the content, context and everyday experiences, for example, teachers' knowledge in South Africa can be different from that in Lesotho because each group constructs knowledge differently. The meaning is given to a group of people because there is a relationship between how one understands knowledge and what informs it.

In the 1980s, educators were concerned with how they could improve teachers' knowledge and the idea of a "knowledge base for teaching" emerged, based on the argument that it should be framed by teacher education and inform their practice (Hashweh, 1987; Leinhardt, 1983; Shulman, 1987). However, attention focused on how teachers managed their classroom, with less on how they delivered their content knowledge within their classroom. This begs the question as to whether an emphasis on both might constitute good classroom practice.

The significance of teachers' content knowledge (CK) is identified as crucial to good science teaching (Friedrichsen et al., 2011) and, according to Shulman, various forms of knowledge base are:

- "content knowledge,
- general pedagogical knowledge
- curriculum knowledge
- pedagogical content knowledge
- knowledge of learners and their characteristics
- knowledge of educational contexts
- knowledge of educational ends, purposes, and values, and their philosophical and historical grounds" (Shulman, 1987:8).

The above issue of Shulman's various forms of knowledge base has been dealt with by many prominent researchers internationally and nationally. For example, Duncan (1998) distinguished Shulman's "how" teachers use their knowledge base and extended the clarification to "what" constituted that knowledge. The "what" was clarified as the nature of scientific knowledge teachers should possess to transfer it to the learners. According to Abd-El-Khalick and BouJaoude (1997), when teachers understand the theories and have knowledge of concepts in the science discipline they will be in a position to reorganise and make it accessible to learners. In so doing, teachers relate science to learners' everyday activities and make it relevant to their education.

As postulated by Shulman (1987), CK as a form of knowledge base has been documented but less focus has been on teachers' science content knowledge

(TSCK) or how it influences their classroom practices. Diamond (2013) argues that most scholars have focused on pedagogical content knowledge (PCK) rather than CK, whilst in the 1970s and 1980s some scholars tried to explain teachers' content knowledge without studying how their CK affected their classroom practices (Abd-El-Khalick & BouJaoude, 1997). Priority in research focused on PCK, probably because it was seen as "the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (Shulman, 1987:8).

Relatively, CK is seen as a more general form of subject matter knowledge (Diamond, 2013) that could be attributed to individual knowledge. The teacher is responsible for grasping the gist of the subject content henceforth they can make it accessible for the learners in acquiring it. Ball, Thames and Phelps (2008) identified a gap in Shulman's work concerning how it related to teachers, noting that it was not subject-related, and categorised it into domains, namely, common content knowledge (CCK), specialised content knowledge (SCK) and horizon content knowledge (HCK). The first, CCK, was the general knowledge possessed by the majority of educated adults, while SCK was the "the knowledge for teaching which is detailed in a way that goes beyond what is needed in everyday life and, moreover, is not necessarily known to other professions" (Campton & Stephenson, 2014:14). In physical education, Ward (2009) considered SCK as a realm focusing on knowledge of instructional tasks and student errors. Selecting, designing classroom activities, explaining and presenting curriculum items are skills that contribute to SCK (Janna et al., 2019). The SCK was found applicable in the classroom because trained teachers were in the position to explain further a concept that was challenging to learners and eradicate their misconceptions generally found in science concepts. The third, HCK was related to how topics relates to one another within the curriculum (Jakobsen et al., 2013).

Ball et al.'s (2008) study focused on mathematical content knowledge while addressing CK, and Ward (2009) also addressed CK in physical education. In elementary education, much work has focused on mathematics in favour of English and science, with less attention paid to early childhood education (Vokos et al., 2017). When addressed, the common research question has been on measures of content knowledge for teaching (CKT) in relation to practice and students' learning (Vokos et al*.,* 2017). This study is based on the work introduced by Ball et al., (2008), because teachers' content knowledge in science is applicable to the classroom. For the feasibility of this study, focus is on floating and sinking concepts as they are the ones pertinent to early childhood. I assume they draw on CCK, SCK and HCK such that they can be located and identified during teaching and learning.

1.2. Background

This section presents the background to the study, with focus on traditions and contemporary issues of early childhood education. Grade R in Lesotho's education system and science learning are clarified in this section.

1.2.1. African traditions of early childhood in Lesotho

Traditions of early childhood in Lesotho indicate that child upbringing was a responsibility of parents, grandparents, siblings, relatives and the community at large (Matšela 1978). Women took the role of child minding whilst grandparents assisted children to learn from their environment through interacting and exploring it. In this way, children developed physically, mentally, socially, emotionally, spiritually and morally. Sebatane and Lefoka (2004) found that due to the advent of paid employment, increasing levels of poverty, brought about by development, forced women to leave their children to go to work. Also, increased urbanisation in families forced women to leave behind their extended families and homes to find work in urban areas. Traditional social ties were several and the tight economic conditions meant that families became dependent on salaries without the support from agricultural production. In those circumstances, children were left uncared for, poorly fed and generally left loitering.

In 1972, the Lesotho National Council of women and the Lesotho pre-school and Day Care Association started an early childhood programme as pre-schools, day care centres, kindergartens, play schools and crèches, to take over responsibility for looking after children of working mothers (Mwamwenda, 2014). By then, children's education was not standardised, and each proprietor offered to teach anything they wished. In 1989, the Ministry of Education in Lesotho established Early Childhood Care and Development (ECCD) centres to which an increasing number of teachers were recruited, many of whom were untrained or had a low educational background (Sebatane & Lefoka, 2004). In 2001, in response to the needs of children from poor families who were unable to access ECE, the government introduced home-based ECE in four of the ten districts of Lesotho.

African society regarded education as a means to an end, not as an end in itself. It was generally for an immediate induction into society and a preparation for adulthood. African education emphasised social responsibility, job orientation, political participation, spiritual and moral values. Children learnt by doing, being engaged in participatory education through ceremonies, rituals, imitations, recitation and demonstration. Recreational subjects included wrestling, dancing, drumming and racing, while intellectual training included the study of local history, legends, the environment (local geography, plants and animals) poetry, reasoning, riddles and proverbs, as well as storytelling (Matšela 1978).

1.2.2. Contemporary issues concerning ECD in Lesotho

As a member of United Nations (UN), Lesotho participated in a number of forums, conventions and agreements, regionally and internationally. The forums dedicated their focus to improving quality education and policies that would best suit each nation. The regional forums include the Southern Africa Development Community (SADC) protocol on education and training and the New Initiative for Africa's Development (NEPAD) human resource development initiative (MoET, 2011). The international forums in which Lesotho participated were the Education for All (EFA), the Millennium Development Goals (MDG) and the Sustainable Development Goals (SDG), to develop its polices for quality education, among other issues. Therefore, the Integrated Early Childhood Care and Development (IECCD) Policy assists Lesotho to achieve EFA initiative in improving basic education featured in Goal 1, which calls for, "expanding and improving comprehensive early childhood care and education, especially for the most vulnerable and disadvantaged children" (MoET, 2011:20). The IECCD policy attests to improving services and quality education as a basis for UN agreements.

The MGD ascribe to "universal primary education" in which Lesotho adopted an Education Policy Act that seeks to "make provision for free and compulsory education at primary level" (Education Act, 2010:163). To access this opportunity, the government's policy of Free Primary Education (FPE) informed unlimited access to primary schools. Most Grade Rs are attached to primary schools and therefore are free, without school fees. Owing to the MDG, the Lesotho National Vision 2020 ensures that the educational sector shall "… develop a human resource base" (UNESCO, 2014a), thereby upgrading or establishing educational and training institutions. The Lesotho College of Education (LCE) offers certificate and diploma courses in ECD for preschool teachers (LCE, 2020), thus ensuring development of human resources. In 2007, the LCE, through the guidance of an IECCD unit from the MoET, trained its first batch of 30 preschool teachers as a way of formalising education and developing human resources. The first cohort of the Diploma in Education (Pre-school and Foundation Phase) was trained in 2020 (LCE, 2020).

In Lesotho, the period of early childhood is between 0 to 8 years of age, considered the time of greatest growth and development, when the brain develops most rapidly, and a period when walking, talking, self-esteem, vision of the world and moral foundations are developed (MoET, 2013). The early years of life are critical to the development of intelligence, personality and social behaviour. Research on brain development has found that if key mental, physical and social capabilities are not well developed from the onset, especially if neurological damage occurs, the learning potential is adversely affected (Britto et al., 2017).

1.2.3. Locating Grade R in Lesotho's education system

Clarification of Grade R is essential in the Lesotho context, falling as it does within the Foundation Phase of primary education. Some scholars often refer to this as an early childhood phase, which according to UNICEF (2017) is from 5-6 years. In the phrase "Grade R", R stands for Reception in full. Reception classes ensure smooth transition and readiness for Grade 1. A brief discussion of the structure of the Lesotho education system follows, particularly on the structure of the different phases, and locates Grade R within the Lesotho education system (See Figure 1.1, below).

Grade 000 (from birth to three years) and Grade 00 (four to five years) are not part of the formal schooling system and are referred to as pre-primary education. The aforementioned Grades are directly supervised by the IECCD unit of the MoET. The formal education system is divided into three main levels, namely, primary school, high school and higher institutions. Grade R is attached to early grades in primary and forms part of the Early Childhood Education (ECE), which encompasses Grade R to Grade Three. Although it is in primary schools there is not yet an established mechanism in place for teachers to assess Grade R at the end of the year to be promoted to Grade 1. Grade R classes are also found in different forms of preschools around the communities, including home-based, with parents not paying school fees, run by volunteers with meals donated from the World Food Programme, or centre-based, with school fees paid (MoET, 2011).

The Intermediate Phase is also part of the primary school system and includes Grades 4 to 7. High school education is composed of Grades 8-11, all of which are the results of the New Integrated Curriculum, with higher education offering certificates, diplomas and degrees. Of interest in this study is the ECE level within which Grade R falls. Figure 1.1 below is an illustration of the structure of the Lesotho education system.

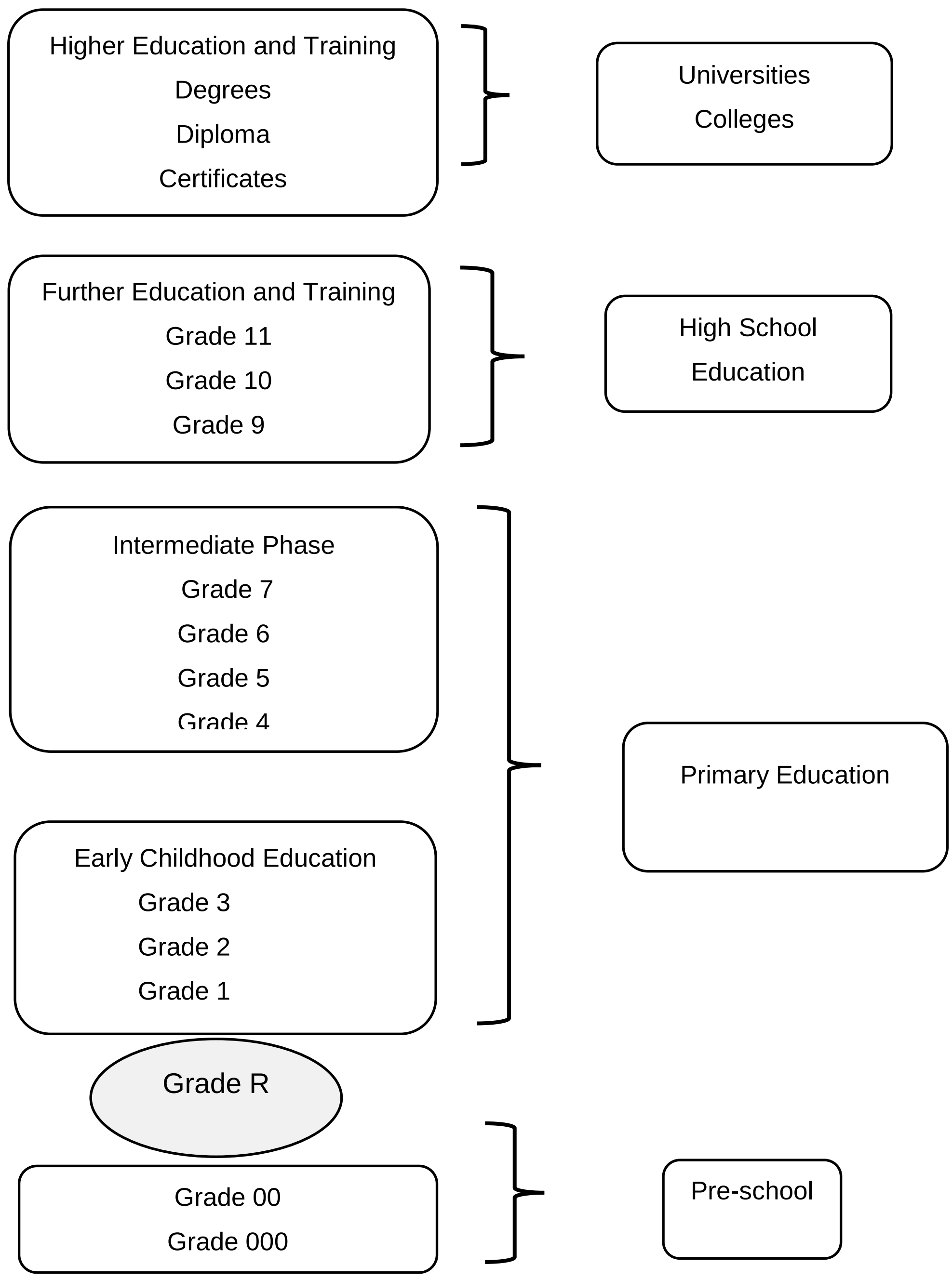


Figure 1.1: A diagrammatic representation of the structure of the Lesotho education system

There are three learning areas in Grade R, namely, Literacy, Numeracy and Life Orientation. Science concepts are treated under Life Orientation, the objective of which envisages learners being able to take care of themselves and their environment (MoET, 2011). Concepts such as “myself,” “environment,” “plants,” “soil,” “water,” “diseases,” “safety,” “food and nutrition,” “animals” and “simple toys” are taught in Grade R. Floating and sinking of objects is classified as the sub-theme of water.

1.2.4. Science learning

Several researchers agree that the sole goal of foundation phase education and its interventions is to support learners’ achievement of knowledge and skills associated with later social competency and scholastic victory (Broström, 2015; Kalley & Psillos, 2001; Sackles et al., 2011). Investigations indicate that there are critical issues of preschool classrooms which require emotional support from teachers to learners (Diamond et al., 2013). That in turn will promote a positive environment which is crucial when teaching and learning are taking place. Small children observe and think about what they are observing, therefore to support how they learn in that way teachers need to support the opportunity to learn by observing, researching, comprehending, participating, bringing forward children’s ideas and using their creativities (Akçay, 2016).

Andersson and Gullberg (2014) conducted research in which they wanted to determine how children conceptualise floating–sinking and found the activities with children unsuccessful as their thoughts about it were not developed. Misconceptions were reported and it was concluded that teachers did not support children’s conception of the topic. The content of science known by the teachers to support learners’ conception of the topic is questionable. The gap identified in Andersson and Gullberg’s (2014) study is that the focus of the research was on learners rather than on teachers, as this study aspires to investigate. It is necessary to conduct a study that explores the stake taken by the teachers in learners’ misconceptions of the topic and how they could be rectified.

In another survey study, Akçay (2016) investigated the views of preschool facilitators and their competence in teaching science topics in their classroom. Most teachers believed that science is intangible and difficult for children to comprehend. As a result, less time is spared for science activities (Akçay, 2016), and teachers seemed to have limited scientific content knowledge (Saçkes et al., 2011; Akçay, 2016). Another longitudinal study, conducted by Saçkes (2014) on how often science is taught in the foundation phase, reported that facilitating experiences and orientations of facilitators on curriculum determine the frequency of teaching science. Other factors that determined frequency were the available sources and teachers' professional development (Saçkes, 2014). The study by Akçay (2016) was on teachers' competences in teaching science, while Saçkes (2014) explored frequency in which science was taught in preschools. Neither study addressed teachers' science content knowledge so it is necessary to explore that of teachers and how it shapes their classroom practices.

Learning through play is considered important in early childhood education, hence Bulunuz (2013) used play to establish its impact on teachers' transmission of science in early childhood settings. Observation of learning selected science concepts led to discoveries that learners often understood them through play rather than through direct instruction, because they were more engaged. Though play seems important in teaching in the early childhood setting the focus of this study is not on play and its impact on learning. However, it should be noted that "play" could be used by teachers as one of the strategies of teaching science.

There is free play time in preschools in which opportunities to learn is enhanced and learners have access to what they want to play. Wishing to know what they do in their free time, Nayfeld et al. (2011) conducted a study in 'science corner.' Despite materials that stimulated learners' interests, it was discovered that teachers spent less time in the science corner. Following an intervention initiated by placing a balance scale to make the corner attractive it was discovered that vocabulary increased, so it could be concluded that if teachers' content knowledge were of high quality they could spend more time in the science corner and put in attractive materials to capture learners' interest.

Another study surrounding the worth of science in the foundation phase was conducted by Greenfield et al. (2009), who took into account factors that contributed to classroom learning. That was stimulated by lower scores in science than in other learning areas, while time management and teacher competences were found to be barriers to teaching science.

None of the above studies in early childhood focused on science knowledge of preschool teachers or how such knowledge influenced their classroom practices. A close study conducted in Greece, however, tested pre-school teachers on how their science content knowledge shaped their answers to everyday science questions in the classroom (Kallery & Psillos, 2001). It mapped how teachers responded to questions and found poor levels of science knowledge. Although my study is on science content knowledge of pre-school teachers (Grade R), it deviates from the Greek study by focusing on science concepts rather than learners' questions.

Globally, most prior studies focus on teachers' science content knowledge in elementary or high school, and higher institutions, with little focus on early childhood learning. For instance, Oh and Kim (2013) found that a high percentage of Korean teachers regarded themselves as unprepared to teach science concepts while in Jamaica teachers reportedly taught science topics they only understood. In Alabama, Iowa and Kentucky, Kinghorn (2013) discovered that elementary and intermediate science teachers lacked CK, whilst In Finland, primary educators could not satisfactorily answer open-ended questions regarding photosynthesis (Södervik et al., 2014). Likewise, following analysis with Trends in International Mathematics and Science Study (TIMSS) results with Grade 4 teachers, Spaull (2013) attests that teaching science in South Africa is challenging as poor teachers' content knowledge is reported. Van Driel et al. (2002) addressed theory of matter to test teachers' CK in secondary, while Hashweh (1987) tested photosynthesis and levers to experienced secondary science teachers. As far as I know, there is no study in Lesotho that focuses on science teaching and their content knowledge in the foundation phase, especially in Grade R.

1.3. Problem Statement

Considering various studies that have been identified in this research into science teachers' content knowledge and classroom practices at many different levels of learning (Akçay, 2016; Andersson & Gullberg, 2014; Bulunuz, 2013; Diamond et al., 2013; Hashweh,1987; Kallery & Psillos, 2001; Kinghorn, 2013; Nayfeld et al., 2011; Oh & Kim , 2013; Saçkes, 2014; Södervik et al., 2014; Spaull, 2013; Van Driel et al., 2002), it is evident that little exploration has taken place of the issues of their science content knowledge or classroom practices in early childhood settings. Of the existing work, little focus has been on mapping preschool TSCK to classroom practices, but rather, prior studies demonstrate a desolate picture of Grade R teachers. The particular set of risks faced by children in knowledge and skills of simple science topics has not been documented, nor is there knowledge of the effectiveness of preschool teachers' transmission of science content to the learners. Hence, this study explores TSCK and how it shapes classroom practices. Watching teacher trainees teach science concepts to preschool learners helped me focus on the kind of knowledge and skills needed. My focus is directed to the topic "floating and sinking" as one of the topics taught in preschool.

1.4. Significance of the study

This study explores how Grade R teachers' science content knowledge influences their classroom practices. My aspiration to embark on this scholarship arose from my experiences as a preschool teacher trainer and the concerns of United Nations' Sustainable Development Goals. It is of concern that:

> 43% of children younger than five in low and middle income countries are at risk of not achieving their developmental potential, partly due to failure to apply emerging scientific knowledge on nurturing care to shape young children's development, and partly a failure to take action at scale, using a multi-sector approach across key stages in the early life course (Britto et al., 2017:93).

Lesotho is a low income country that faces the risk of not developing young ones to their full potential. Apparently, failure to apply emerging scientific knowledge can be traced back to how teachers taught learners as early as Grade R.

As a former Foundation Phase teacher and now an ECD teacher trainer, having taught science in Grade 1 I had various occurrences in which Grade R learners arrived in my class short of science experiences, if any. This was evidenced by their eagerness to experiment or their obvious reservations to manipulate objects during science class. While on teaching practice, I realised that ECD teachers gave Science little priority compared to Numeracy and Literacy activities. I observed them teaching science in a teacher-dominated manner, giving learners little room for experimenting. Indeed, few of the teachers with whom I interacted mentioned that their priority was to help learners to read and write, or to understand basic Mathematics. The minimal mention of Science stimulated this study because I wished to find out how Grade R science is taught in the classroom and how teachers' science knowledge influences their practices. Therefore, mapping Grade R teachers' science content knowledge with their classroom practices calls for inquiry, specifically in Lesotho, where little information has been documented.

This study will inform researchers interested in early childhood education of practices, beliefs and attitudes of preschool teachers when teaching science, whilst institutions training preschool teachers will be offered guidance on science concepts and the way they could improve their practices. The findings should inform curriculum designers on how to strengthen areas that would contribute to teaching of science. Necessary interventions and content evaluation will be reckoned.

1.5. Theoretical framework

Osanloo and Grant (2016:12) defines a theoretical framework as a:

> foundation from which all knowledge is constructed (metaphorically and literally) for a research study and serves as the structure and support for

the rationale for the study, the problem statement, the purpose, the significance, and the research questions.

In this study, “theoretical framework” is understood as a supporting structure in which the researcher builds a rationale for conducting the research and choosing appropriate questions for study, or as a lens through which to focus on the topic, informed by theory.

The theoretical framework regarded as appropriate to achieve the objectives of this study is Shulman’s Teacher Knowledge Framework and Content Knowledge for Teaching (CTK) framework. Shulman (1987) suggested unification of two types of knowledge, pedagogy and content, hence pedagogical content knowledge (PCK), an amalgamation of the two, is defined as that “which goes beyond knowledge of subject matter per se to the dimension of subject matter for teaching.” Several developments accelerated concerning the use of PCK, including those by Tamir (1988), Grossman (1990) and Magnusson et al. (1999). Other scholars acknowledged that PCK include subject matter, or content knowledge, featured in Shulman’s knowledge base (Fernández-Balboa & Stiehl, 1995; Marks, 1990), and Kind (2016) agreed that teachers need both content knowledge (CK) and PCK for teaching.

Referred to by Shulman (1986:9) as “… the amount and organisation of knowledge in the mind of the teacher,” CK is seen as a prerequisite of PCK (Van Driel et al., 2002), whilst Ball et al. (2008) improved on Shulman’s conception by using it in mathematics, arranging CK into three domains:

i) *common content knowledge* (CCK), the type common to other professionals gained from their schooling experience. For instance it is known that some objects float in water while others do not.

ii) *specialised content knowledge* (SCK), the specific knowledge needed for the teaching practice which is not needed in other professions (Zambak &

Tyminski, 2017). This involves a teacher's ability to use acquired CCK to help learners understand why some objects will not float or sink as expected

iii) *horizon content knowledge* (HCK), which calls for awareness of how the topics are related over the span of the subject included in the curriculum (Jakobsen et al., 2013).

In teaching any subject, such as science, teachers' content knowledge is important (Jakobsen et al., 2013) as they need to be able to know their content well and structure it in such a way that it will be easy for the learners to understand. It is expected that teachers are equipped with sufficient content from their training institutions about science instruction and practice. Those from training institutions should be able to structure their lessons in such a way that the objectives will correspond with learning activities as well as assessment criteria. In the classroom, teachers are expected to plan, initiate instruction and produce what they planned, therefore they need to be aware of the procedures and strategies that will allow learners to interact actively in a science classroom. Blending the three domains will help them impart their content to learners.

While teaching science content, I anticipate that interactional tasks of teaching would be observable during classroom practice as teachers would apply their knowledge of content, teaching strategies and learners' experiences. Floating and sinking concepts would be used as science concepts while CTK would be used as a theoretical lens to measure teachers' knowledge and their practices. This is in line with Janna et al.'s (2019) advice on applying interactional task of teaching in the classroom by selecting, designing classroom activities, explaining and presenting curricular items. Content Knowledge for Teaching framework is relevant to my study as teachers' beliefs, actions and context will help to answer *what* and *how* questions and therefore a pragmatist paradigm will be employed. According to Creswell (2014), researchers engaging pragmatist view, do not see the world as an absolute unity. So I would cooperate with the respondents in answering the questionnaire and interact with them during observations and interviews, thus helping me understand how their science content knowledge on floating and sinking influences their classroom practices.

1.6. Research questions

I engaged research questions in order to address the research problem with the intention of establishing the influence of Lesotho Grade R teachers' science content knowledge on their classroom practices. The main research question seeks to generate data on the influence of Grade R teachers' science content knowledge on their classroom practices by addressing the following issue:

> What is the influence of the science content knowledge of Grade R teachers in Lesotho on their classroom practice?

The following secondary research questions are used to unpack the main research question:

1. What is the science content knowledge of Grade R teachers in Lesotho on selected science concepts?
2. How do Grade R teachers teach the selected science concepts to their learners?
3. How does teachers' content knowledge of science shape their classroom practice?
4. How can the Grade R teachers' content knowledge and practices on science be understood and/or explained?

1.7. Objectives of the study

The aim of this research is to explore the science content knowledge of Grade R teachers in Lesotho with respect to the science concepts and its influence on their classroom practices.

The specific objectives are to:

- explore the science content knowledge of Grade R teachers in Lesotho on selected science concepts
- investigate how Grade R teachers teach the selected science concepts to their learners
- examine how teachers' content knowledge of science shape their classroom practice
- synthesise how Grade R teachers' content knowledge and practices on science can be understood and/or explained.

1.8. Research design and research methodology

I followed the explanatory sequential design, which is a mixed method. This observes quantitative and qualitative methods as one method conducted successively after one another (Piccioli, 2019). A sequential explanatory process starts initially with the quantitative phase, to be followed-up by qualitative phase based on the results of the quantitative. According to Piccioli (2019:430), "the quantitative results are therefore useful for proceeding with formulating questions, performing sampling, or having the data on which to base the subsequent qualitative phase". Therefore, in this study, the quantitative study was prioritized to give direction of the research that was better clarified by the second method. Creswell (2014) argues that every method can be biased and weak but that the collective compilation of qualitative and quantitative data counterbalances the flaw of each approach. I engaged both methods in this study because quantitative method gave me objective views of teachers' science knowledge whereas qualitative method provided a picture of how that knowledge influenced their classroom practices. A pragmatist paradigm was used because it considers both objective and subjective views of participants.

A questionnaire, lesson observations, interviews and document analysis were used to collect data. A useful instrument for collecting survey information (Cohen et al., 2011), the questionnaire was used to conceptualise Grade R teachers' science content knowledge. A survey of 100 Grade R teachers was conducted in the first phase in order to inform the second, in which a series of observations with a sub-sample of four teachers from the main sample was engaged. Observation is defined by Cohen et al. (2018) as the orderly procedure of recording the performance of participants without disturbing them. Classroom observation enabled me to analyse classroom interactions, and I was able to obtain first-hand information as opposed to reports given by participants in the questionnaire. An arrangement was made to ask the participant to be observed when the topic "floating and sinking" was taught.

Interviews were engaged in the second phase, conducted with the same observed teachers after school to avoid interruptions and disturbances. An interview schedule was prepared to guide the process. According to Silverman (2011), interviews are useful for gathering evidence, exploring behaviour and eliciting explanations. I conducted face-to-face interviews with the intention of understanding beliefs, knowledge, attitudes and insights of teachers into teaching science concepts. Semi-structured interviews allowed me to determine questions and to probe the participants for clarity and motivation for their answers. Interviews with the participants continued until the point when no more new data arose, that is, the point of saturation.

Document analysis was used to add to the reliability of this study. Creswell and Creswell (2018) regard documents as a "stable" source of information which can be physically manipulated at any time the researcher wishes to peruse them. Data documents could be published or unpublished, for instance, reports, administrative documents and newspaper articles. In this case, analysis of Grade R teachers' lesson plans were carried out to complement observation and interview protocols as a follow-up from the four participants. The researcher asked permission from the teachers to photocopy lesson plans, to be used as a form of reference while conducting data analysis at home.

Sampling is a crucial element of research in which sample size, sample error, sample representativeness, access to the sample and sampling strategies are key issues (Cohen et al., 2011). Sampling procedure is clearly explained in section 3.5.4. Purposive sampling was followed, which according to Cohen et al. (2018) is based on the idea that participants define some attributes that make them the owners of the data desired. A minimum of 100 Grade R teachers in Maseru district were selected to respond to the questionnaire. Grade R teachers who were attending their monthly meeting in Maseru district were confronted with the researcher's intentions of the study, and 100 were asked to volunteer to be part of the study. They responded to the questionnaire requiring them to talk about their science content knowledge. Convenience sampling was used for interviewing, observation and analysing lesson plans of the four teachers who were part of the main sample. The idea was to verify information established during the first phase and to capture teachers' own knowledge, beliefs and insights regarding science knowledge and its application.

Since this research follows a mixed methods design the quantitative and the qualitative data was analysed sequentially (Creswell, 2014), the results of the former being used to plan a follow-up for the latter. Firstly, I analysed questionnaires using Statistical Analysis System (SAS), which is commonly used in educational research and is available in my institution. It helped me analyse perceived teachers' content knowledge and determine how their knowledge influenced their classroom practice. Lastly, results were presented in tables or figures and analysed to inform the qualitative phase.

Raw data generated from observations and interviews, as well as in analysis of lesson plans, were prepared and organised for data analysis. The open coding process saw essential concepts and patterns identified and categorised into themes. Lastly, interpretations of the results were made and integration of results presented in both phases completed. Figure 1.2 (below) displays an overview of the sequential explanatory design process followed in this study.

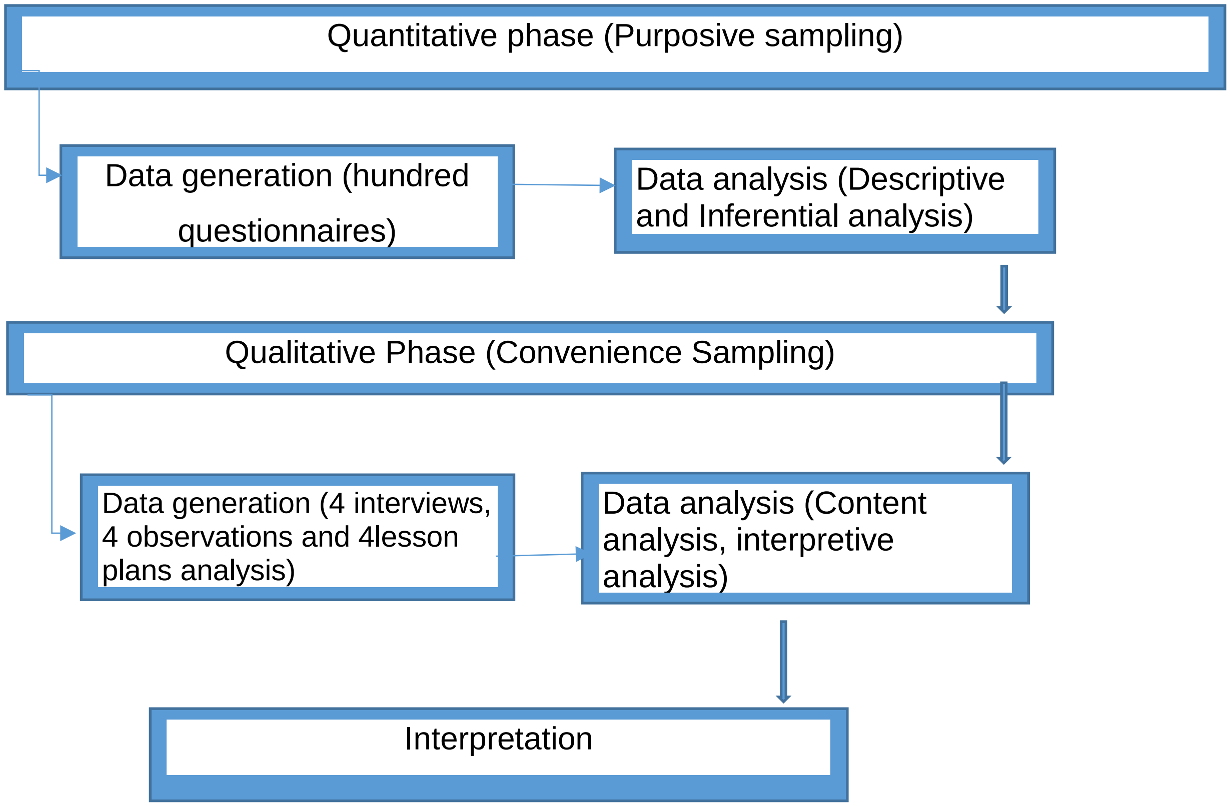


Figure 1.2: An overview of sequential explanatory design process followed

1.9. Limitations of the study

The first limitation of this study was that only Grade R teachers in Maseru participated. The foundation phase is the period for learners between three and eight years, whereas Grade R learners fall within the five to six year old group. What happens before or after was not studied, therefore knowledge of teachers' science content in those other years of development is not known. However, the results of the study would be useful to the Lesotho Ministry of Education and Training and to other researchers.

Another limitation of this study was that most Grade R teachers were trained by the researcher from the LCE. This factor possibly influenced the results negatively as participants might not have felt free to reveal the true phenomenon of what they normally did. They might have merely given responses that were meant to impress their former lecturer. Against the background, the researcher had to make them aware that the situation was different from when they were observed as students and therefore they were encouraged to feel free.

One more limitation emanates from the choice of one content area (float and sink) over other areas of science in early childhood. This may pose a problem as literature shows that teachers are more comfortable teaching concepts that they understand (Oh & Kim, 2013; Robinson, 2017).

1.10. Delimitation of the study

The study focused on Grade R teachers in Lesotho who had formal teacher training at the LCE and earned a Certificate in Early Childhood Education (CECE). The terrain in Lesotho comprises urban, semi-urban and rural areas, each of which provided teachers for the sample. Grade R teachers teach science concepts as prescribed in the curriculum guide, prepared by the MoET in the Early Childhood Care and Development Unit. They answered the questionnaire regarding their insights into the science content knowledge and classroom practice. A smaller sample from the main sample was observed, interviewed and their lesson plans observed to ascertain their experiences relating to how their science content knowledge influenced their classroom practices in real life.

1.11. Ethical considerations

It was important to ensure consent was obtained from participants in this study in order to gain their trust. Silverman (2011) reminds researchers of the need to remember that they are indeed entering the personal surroundings of participants when they embark on a research study. Hence, researchers have a responsibility to “respect the rights, needs, values and desires of the participants” (Creswell, 2014:202). As such, a number of ethical issues were considered when collecting data, as detailed below:

a) **Ethical Clearance** from the Ethics Committee of the University of the Free State (UFS) was sought and approved. I filled in the Research Information

Management System (RIMS) form available from the UFS website and submitted all the documents necessary in order that I be given a permission to collect data. My research proposal, research tools, request letter to the Ministry of Education and Training, school principals and consent letters to the teachers formed part of submitted documents that were reviewed and approved by the UFS ethics committee.

b) **Ethical approval** from the Lesotho MoET was requested as the participants of this study were Grade R teachers working in schools for the Ministry of Education. I submitted requisition letter to the senior education officer of the Lesotho MoET to present my study, how I will work with the teachers and how the study would benefit the ministry.

c) **Informed consent.** As soon as I received approval I visited the schools in which the participants taught to ask for permission from their principals to interview, observe and have their lesson plans analysed. As soon as principals agreed, I sent consent forms to the participants. General information that addressed issues of purpose of the study, value, right to withdraw and confidentiality were indicated in the form. Airasian (2014) is of the opinion that involvement of research participants without their consent will impair their right to self-determination.

d) **Anonymity and confidentiality.** Participants were made aware that their names would not be used, rather pseudonyms to protect anonymity were used. This was in line with Airasian's (2014) suggestion concerning participants' anonymity and freedom from exposure to risks. Participants were assured that all the information gathered would be used for the purposes of this research only and kept safely until destruction after five years.

1.12. Clarification of terms

The following key terms were understood as follows.

Common content knowledge (CCK) is the knowledge and skills used in all professions and settings (Ball et al., 2008). In this study it is used in relation to what teachers understand as ‘floating and sinking,’ not deeper knowledge of why objects float and sink.

Content knowledge (CK) refers to the body of knowledge about what to teach and what the learners are expected to learn in a given subject area, as in science (Shulman, 1987).

Early childhood years refers to a period that ranges between birth to eight years of age, during which time children acquire strong foundations for learning and life. They need supportive, caring and nurturing environments in order to develop fully (MoET, 2011:1).

Grade R: Grade R is attached to early grades in primary and forms part of the Early Childhood Education (ECE). In this grade, learners are prepared for formal learning in primary school.

Horizon content knowledge (HCK) is referred to as the general knowledge of the previous and the forthcoming, particularly in this context what is relevant from pre-schools to primary schools (Fernández & Figueiras, 2014).

Science in the Foundation Phase is explained as “building on the learner’s curiosity and ways of knowing, and encourage investigation of the natural world with a sense of wonderment” (Department of Education, 2003b:24). This study recognise young learners’ science as an extension of their everyday life which should be treated with care by their teachers.

Specialised content knowledge (SCK) is the knowledge that enables the teacher to determine viability of non-standard approaches, identify learners’ common errors and be able to create visual representations to illustrate a concept. Among other things in the context of this study, if teachers are able to explain why objects float and sink it is regarded as the boundless SCK needed by Grade R teachers.

Subject matter knowledge refers to the evidence or tenets of a particular subject which define it and set that subject aside from others (Shulman, 1987). Within the context of this study, it is sometimes referred to as content knowledge which the teachers should possess and make accessible to learners when needed.

The foundation phase is the first phase of the General Education and Training Band: Grades R, 1, 2 and 3, including learners who are six to nine years of age (Department of Education, 1997). In Lesotho, the Foundation Phase forms part of basic education located in primary schools. It runs from Grade R to Grade 3.

1.13. Organisation of chapters

This thesis is organised into the following five chapters:

Chapter 1: Background and orientation to the study has provided a general overview of the study. This included background, which set the context of the study such that readers would be able to follow what inspired me to embark on it. The problem statement included in this chapter indicates the gap that I sought to fill. Shulman's Teacher Knowledge Framework and Content Knowledge for Teaching (CTK) framework are introduced as the anchors of this study. The significance of the study, research questions, aims and objectives were also outlined. Deliberation was made on research methodology, limitations and delimitations, ethical considerations, clarification of terms and how chapters are organised.

Chapter 2: Literature Review presents existing literature on the various related arguments attributed to content knowledge of teaching, effective classroom practices and how teachers acquire content knowledge. Attention is paid to teachers' science content knowledge internationally, nationally and Lesotho. Conceptual understating and misconceptions regarding floating and sinking concepts featured in this study are looked at. How teachers teach science concepts and the knowledge gap established in this study are discussed. Shulman's Teacher Knowledge Framework and Content Knowledge for Teaching (CTK) by Ball et al. (2008) form the framework of the study.

Chapter 3: **Research design and methodology** discusses the research design and methodology in detail. The pragmatic paradigm and sequential explanatory mixed methods design are explained. A questionnaire, observations and interview techniques of collecting data, as well as purposive sampling, are discussed. Data analysis methods and ethical issues are presented.

Chapter 4: Data presentation, analysis and the researcher's interpretations are discussed in this chapter.

Chapter 5: Conclusion and recommendations are drawn and made respectively, in line with research questions and literature findings on studies related to the topic.

1.14. Conclusion

Firstly, this chapter introduced the reader to the background of the study on African traditions of early childhood and contemporary issues concerning ECD in Lesotho. Also, issues pertaining locating of Grade R in Lesotho education system and science learning were discussed. Based on the literature on different contexts, a problem statement was clearly articulated and the significance of the study was outlined with the aim of guiding readers on why it is important to undertake the study. It was informed by the support of categories elaborated by Shulman's (1986) and Ball et al.'s (2008) theoretical framework. Then, the research questions were presented to investigate how the content teachers have in science influences the way they teach in class. Research design and methodology were clearly explained. Finally, the limitations, delimitations, ethical considerations, clarification of key terms and how this study was organised were discussed.

The next chapter will focus on a literature review related to Grade R teachers' science content knowledge and classroom practices. It will be followed by chapter 3, which will describe how the research methodology will be pursued. Chapter 4 presented, analysed and interpreted data and chapter 5 will conclude the study with discussions and recommendations.

Chapter 2. REVIEW OF THE LITERATURE

2.1. Introduction

The previous chapter introduced the background to this research, highlighted and explained the problem statement, theoretical framework and methodology employed. The delimitation explained the focal point of the research, with limitations explained and ideas on how they could be minimised. Selected definitions were given for a clear understanding of the conceptual terms used in the study. An outline of the chapters was given to indicate the structure of the thesis. This chapter is a literature review which focuses on science knowledge and classroom practices of early childhood teachers.

A literature review shapes the research project, which should be informed by the gaps, omissions or unanswered questions found within previous research on a chosen topic (Norlan et al., 2013). I reviewed research that aided my understanding of teachers' science content knowledge (TSCK) in preschool as well as their classroom practices. The gap that informed this study emanates from the inspiration behind TSCK and how it influences classroom practice.

The Literature review includes various discussions of issues found to be important, starting with a theoretical framework that guides this study. I reviewed Teacher Knowledge Framework (TKF) and Content Knowledge for Teaching (CTK) as I found them applicable in this study. The frameworks are extensively discussed through literature to give a clear explanation of how and why I used them.

The review continues with the literature relevant to answering the main research question **"What is the influence of the science content knowledge of Grade R teachers in Lesotho on their classroom practice?"** and the secondary questions outlined in Section 1. 6. The related literature includes international, national and Lesotho perspectives on teachers' CK, its impact on science teaching, effective science classroom, how science teachers acquire their knowledge, preschool science teaching and teacher-oriented practice versus learner-oriented practice. Teaching of science concepts relating to floating and sinking are also reviewed.

2.2. THEORETICAL FRAMEWORK

Shulman's Teacher Knowledge Framework and Content Knowledge for Teaching (CTK) form the framework of this study. The framework is an important structure that seeks to identify and present information in a logical format, with the key factors relating to the phenomenon under investigation (Kerlinger, 1986).

2.2.1. Shulman's Teacher knowledge Framework

In the 1870s, researchers were concerned as to how they could rework teachers' status into that of professionals, such as lawyers and doctors. Teachers had been regarded only as skilled workers who would transmit knowledge to learners and one had merely to take a basic content test to be licensed to practice. A jump in the 1970s and 1980s saw them assessed on competences that included planning, management and educational policies and procedures. Subject matter was no longer prominent and, as Shulman (1986) argued, an important issue of the "missing paradigm" relegated teaching instruction and how content related to student knowledge. In addressing the "gap," a teacher programme with either general pedagogy and content knowledge treated as separate entities do not benefit teachers, rather it "is likely to be as useless pedagogy as content-free skill" (Shulman, 1986:8). As a result, Shulman (1987) proposed an amalgamation of the two types of knowledge, pedagogical and content, the intersection of which results in pedagogical content knowledge (PCK) as depicted in the figure below.

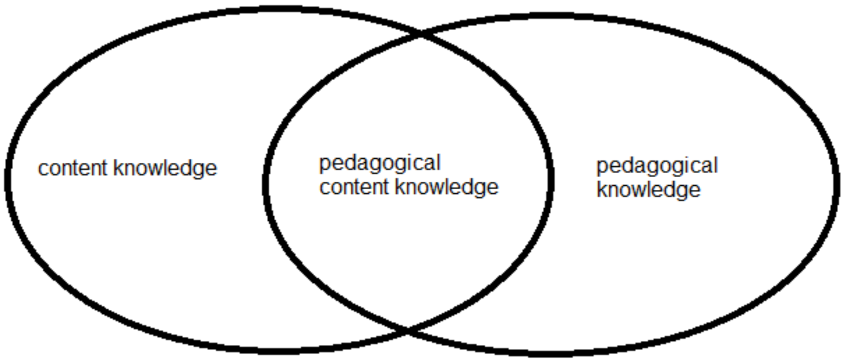


Figure 2.1: PCK amalgamation adopted from Mishra and Koehler (2006)

Shulman (1986:9-10) devised “three categories of knowledge in teaching, namely, content, pedagogical and curricular,” further developed into a list of seven: “content, general pedagogical, curriculum, pedagogical content, learners and their characteristics, educational contexts, and educational ends, purposes, and values, and their philosophical and historical grounds” (Shulman, 1987:8).

Of the seven categories of knowledge base, pedagogical content knowledge (PCK) and content knowledge (CK) are prominent in this study. Shulman (1986:9) describes PCK as the knowledge “which goes beyond knowledge of subject matter per se to the dimension of subject matter for teaching”. His conception of knowledge includes:

> …for the most regularly taught topics in one’s subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations – in a word, the most useful ways of representing and formulating the subject that make it comprehensible to others (Shulman, 1986:9).

A further explanation was made by other scholars, for instance, Grossman (1990), who perceived PCK as consisting of knowledge of strategies and representations for teaching particular topics and knowledge of students’ understanding of conceptions, and misconceptions of those topics. In PCK, Kind (2009) included pedagogy and content that teachers needed to promote learning. Similarly, Ball et al. (2008) write that PCK represents the knowledge teachers use in the process of teaching.

Several developments arose concerning the use of PCK postulated by Shulman. Tamir's (1988) model extended it by including knowledge of evaluation, whilst Grossman (1990) added knowledge of conception of teaching purposes, for instance, knowledge and beliefs about the purposes for teaching a subject at different grade levels. With knowledge of evaluation these were presented in the former and latter models, but not included in Magnusson et al.'s (1999) model, which constructed a PCK model for science teaching that focused on "orientations to teaching science, knowledge of science curricula, knowledge of students' understanding of science, knowledge of instructional strategies and knowledge of assessment of scientific literacy" (Magnusson et al., 1999:3). Some researchers saw Shulman's work differently, with subject matter knowledge (SMK) included in PCK (Marks, 1990; Fernández-Balboa & Stiehl, 1995). Earlier, Bromme (1995) had criticized Shulman's PCK for including "knowledge of students' difficulties" and "instructional strategies" but not considering other factors that contribute to teaching and learning.

Other researchers, such as Kind (2009), acknowledge that teachers need not only SMK but also PCK to be able to teach in schools. However, the former is seen as a prerequisite for the latter because teachers may be knowledgeable in transmitting content, but if that is insufficient and misleading the process would be null and void. Similar conclusions were drawn by Van Driel et al. (2002) and De Jong and Van Driel (2004). Still other scholars advanced Shulman's PCK and directed its attention to topic-specific knowledge. Mavhunga and Rollnick (2011) developed the construct of topic-specific PCK, which as a concept is related to Ball et al.'s Specialised Content Knowledge (SCK) for teaching. Kind (2016) indicates that Shulman acknowledged PCK as a combination of two things, pedagogy and subject-specific content. In this study, PCK is the knowledge base teachers possess that would be revealed by the time they teach floating and sinking concepts in their lessons. Thus, individual PCK can be regarded as an activity each teacher will perform in the classroom, likely to vary, depending on the teacher. Therefore, this study would explain teachers' activities based on their construction of classroom practices.

2.2.2. Content Knowledge for Teaching

Shulman's (1987) CK was improved by Ball et al. (2008) in a framework known as Content Knowledge for Teaching (CKT), as illustrated below (Figure 2.2). CKT is premised on the idea that teachers need to understand subject matter content for teaching in a way that is responsive to students' understanding and challenges (Etkina et al., 2018). Below is the depicted representation of CTK components.

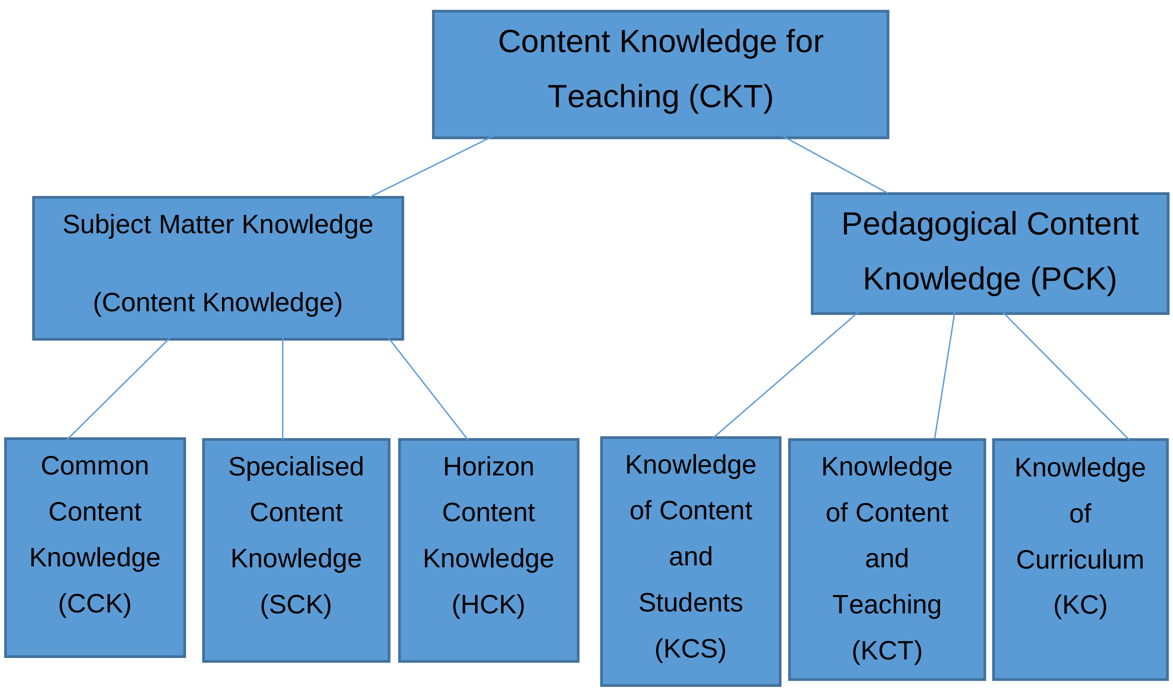


Figure 2.2: Components of Content Knowledge for teaching, as adapted from Ball et al.'s (2008) model

As in many studies carried out in Mathematics and Science education (Robertson et al., 2017), the PCK domain initiated by Shulman (1986, 1987) is regarded as a major reference in guiding this study, while CK re-organised by Ball et al. (2008) anchors a conceptual understanding of it. It explains how Grade R teachers' science content knowledge influences their classroom practices. Even an interest in understanding the CK unique to teaching of mathematics inspired Ball et al. to take a closer look at the "tasks involved in teaching [mathematics] and the mathematical demands of those tasks" (Ball et al., 2008:8). I found it applicable as I explored teachers' science CK. Teachers' tasks were observed during classroom discourse, as their proposal about teachers' unique professional knowledge includes not only PCK but also *specialised content knowledge* (SCK). Therefore, they devised the two into "content knowledge for teaching" (CKT) to represent teachers' specialised professional knowledge.

Scholars such as Ward (2009) used Ball et al.'s (2008) CKT as a conceptual framework in Physical Education. He argues that, without a deeper understanding of content, teachers are unlikely to teach relevant content in their subject. Having reviewed literature by Grossman (1990) on articulation of how teachers' orientations to literature shaped the way they approach texts with their students, and how Wilson and Wineburg's (1988) study linked teachers' background of social studies and classroom representations, I based my research on the conceptual framework of Ball et al.

2.2.2.1 Content Knowledge

Content knowledge (CK) is a knowledge component in its own right, the subject matter that is either taught or learnt (Harris et al., 2009; Keçeci & Zengin, 2017; Koehler et al., 2013). Emphasis is placed on subject matter because teachers are expected to know the concepts they are to teach the learners. For a pre-school teacher these are the ones outlined in the curriculum. Shulman refers to CK as "… the amount and organisation of knowledge in the mind of the teacher," (1986:9) and believes that teachers must be capable of explaining and defining such knowledge to students, such as floating and sinking, so that it makes sense to them. He adds that teachers must be in a position to know the worth of such concepts and how they relate to each other across the curriculum and within other learning areas. Grossman, Wilson and Shulman (1989) allude to CK as the knowledge component that comprises knowledge of the matter and its unifying structure. For Grade R teachers to be competent in CK they have to understand and link concepts that can be learnt prior to and after, for they vividly need to understand the intended concept to be taught when preparing to teach their subject matter. This is in line with Shulman's (1986:9) argument that:

> The teacher has special responsibilities in relation to CK, serving as the primary source of student understanding of subject matter. The manner in which that understanding is communicated conveys to students what is essential about a subject and what is peripheral. In [the] face of student diversity, the teacher must have flexible and multifaceted comprehension, adequate to impart alternative explanations of the same concepts or principles.

Teaching science presents learners with the possibility of applying the content they were taught to solve real-life problems, and use the information or content they learnt to put it into practice. As Shulman (1987:7) claims, "teaching necessarily begins with a teacher's understanding of what is to be learned." Science teachers are expected to understand the concept they are going to teach, organise learning, explain scientific process and help learners draw reliable and valid conclusions.

2.2.2.2 Common Content Knowledge

Common Content Knowledge (CCK) is one of the CK domains in which general knowledge is conceived by any adult who had schooling (Campton & Stephenson, 2014). According to Hill et al. (2007), it is the knowledge of subject matter that was common across professions, as in scientists, teachers and geologists. If teachers knew the concept clearly they would be able to explain it to the learners using correct explanations and recognizing when learners are giving out the incorrect answers (Ball et al., 2008). In line with the explanation above, I consider CCK for this study as an understanding of concepts that most educated adults would know, for instance, a teacher must be able to observe when objects are floating or sinking and give simple explanations of each state. This knowledge is essential, as Ball et al. (2008:399) claimed:

> When we analysed videos of teaching, it was obvious that such knowledge is essential. When a teacher mispronounced terms, made calculation errors, or got stuck trying to solve a problem at the board, instruction suffered and valuable time was lost.

If Grade R teachers are not conversant with CCK in teaching science concepts, learners are at risk of being presented with misconceptions that are likely to be detrimental to their future leaning development. Classroom instruction is not expected to suffer due to the teacher who is incapable of solving learners' problems or giving out the correct answer.

2.2.2.3 Specialised Content Knowledge

Specialized content knowledge (SCK) concerns the knowledge for teaching which is detailed in a way that goes beyond what is needed in everyday life, and is not necessarily known to other people, except teachers (Campton & Stephenson, 2014). This knowledge is further explained as allowing the teacher to engage in tasks specialised to teaching but not needed in other professions outside teaching (Jakobsen et al., 2013). It is the knowledge needed to teach CCK to learners, for example, explaining what is floating and sinking (regarded as CCK) and being in a position to explain to students why things float or sink (regarded as SCK). In this regard, teachers would be able to answer learners' *why* questions, illustrate with use of examples, follow scientific processes and skills logically and be able to identify misconceptions from the learners. Such knowledge is not necessary for swimmers as their goal is to master skills of swimming with less focus on why they float in water. In mathematics, Ball et al. (2008:401) write: "Accountants have to calculate and reconcile numbers and engineers have to mathematically model properties of materials, but neither group needs to explain why, when you multiply by 10, you 'add a zero'." This is because such knowledge is not needed by other professionals. Teachers need SCK to be able to interpret concepts that appear in the curriculum to meet the needs of students in understanding instruction.

As much as Ball et al. emphasised mathematical concepts, I adopted their explanation of SCK related to floating and sinking concepts in science. When reasons are provided for objects that float and objects that sink, as well as following scientific skills and processes correctly, SCK is constituted (Herbst & Kosko, 2012). SCK is characterised as the knowledge not necessarily needed to be taught to the learners but rather be available when the need arises to answer inquisitive questions by the learners (Markworth, Goodwin & Glisson, 2009). In this respect, teachers employ their CCK to accomplish content-related learning goals, but utilize their SCK to overcome possible problems that would need to be addressed during teaching and learning (Zambak & Tyminski, 2017). An example would be when a learner wants to know why a needle sinks yet it is not heavy. If the intention of the teacher is to teach about floating and sinking objects the *why* question would not necessarily be within the scope of the learning goal, however, the teacher would have to respond to the question asked. As in mathematics, an example of why "add a zero" when multiplying a whole number by ten is considered SCK (Zambak & Tyminski, 2017), as is explaining why objects float in water using density, force and particles in molecules.

2.2.2.4 Horizon Content Knowledge

Horizon content knowledge is one of the domains of CK which is framed in CKT initiated by Ball et al. (2008), who as discussed above were interested in mathematical knowledge for teaching. Their definition of HCK was "an awareness of how mathematical topics are related over the span of mathematics included in the curriculum" (Ball et al., 2008:403). My explanation of it would be based on the view in mathematics but adapted to science knowledge. The given meaning suggests that a Grade R teacher would have to understand how early science content will be built upon by students later in elementary school. As a result, connections between science ideas is encompassed in what Hill, Rowan and Ball (2005) describe as "a kind of peripheral vision" that relates to the past, present and future learning. When referring to the concepts of floating and sinking, preschool teachers need to have a clear understanding that objects either float or sink in fluids and that is determined by density of the object and the fluid. As a result only concepts relevant for pre-school would be emphasised. The Grade R teachers have to know what their learners would learn in primary school.

Jakobsen et al. (2013:4642) define HCK as:

> An orientation to and familiarity with the discipline (or disciplines) that contribute to the teaching of the school subject at hand, providing teachers with a sense for how the content being taught is situated in and connected to the broader disciplinary territory. HCK enables teachers to "hear" students, to make judgments about the importance of particular ideas or questions, and to treat the discipline with integrity, all resources for balancing the fundamental task of connecting learners to a vast and highly developed field.

The above definition denotes that HCK is neither common nor specialised as it is about a curriculum progression and it has the larger spectrum of the subject taught. The nature of HCK is to understand the motivation for the given topic, the basics and the core ideas involved for the content. The hierarchical structure in content is perceived to be important as it provides the basis for discerning advanced content that is likely to have a greater reach (Jakobsen et al., 2013). Knowledge of structure leads to progression of continuity that addresses challenges in a more formal way.

Horizon Content Knowledge will "emerge as the theoretical response to the knowledge for teaching in a continuous way" (Fernández & Figueiras, 2014:9), particularly relevant from pre-school to primary school. There must be coherence of content taught to learners from the early to the higher grades.

2.2.2.5 Rationale for using Content Knowledge

This study aims to explore Lesotho Grade R teachers' science content knowledge and how the knowledge they have influences classroom practice. Although the study is based on Shulman's (1986, 1987) PCK, the main focus of this study is to draw attention to teachers' CK as the topic aspires. However, the researcher is aware that the second secondary research question investigates how teachers teach the selected science concepts. The *how* part requires engagement of PCK, in which case, aspects of pedagogy would be covered under the specialised content knowledge (SCK) as it is closely related to PCK (Campton & Stephenson, 2014). Therefore, the influence of Grade R teachers' science content knowledge and how their knowledge shapes classroom practice would be analysed through teachers' CCK, SCK and HCK. The next sections discuss how teachers' content knowledge is maintained, using the stance of international, African and national (Lesotho) perspectives.

2.3. Teachers' science content knowledge: International perspective

In the United States of America (USA), a large percentage of teachers regard themselves as unprepared to teach science (Oh & Kim, 2013). Similarly, in one school in Jamaica, teachers were reluctant to teach science because they had limited content knowledge and disguised their limitations through use of various strategies, such as not teaching science or teaching only those concepts they understood (Oh & Kim, 2013; Robinson, 2017). According to Ghazi et al. (2013), there will always be deficits in learners educated by educators with inadequate science CK, and those learners will not progress in science-based courses. Gaps in TSCK make a significant contribution to teachers' ineffectiveness in delivering science concepts (Andersson & Gullberg, 2014).

In Alabama, Iowa and Kentucky, Kinghorn's (2013) research to identify gaps in TSCK experienced by elementary and intermediate school science teachers while on teaching practice revealed gaps in teachers' knowledge of specific science concepts. In a research study conducted by Sodervik et al. (2014) in Finland, primary educators were not capable of replying to open-ended questions concerning photosynthesis after several attempts to teach the topic to them. The study concluded that teachers with misconceptions on such a topic would have difficulty presenting it to their learners. Unpacking preschool TSCK would therefore be necessary to find how they applied their knowledge in the classroom.

Based on the above perspectives regarding TSCK and the research findings from the studies of Robinson (2017), Oh and Kim (2015), Kinghorn (2013) and Södervik et al. (2014), it is pertinent to consider Grade R teachers' science content knowledge and how it influences their classroom practice. This study gains more significance as to some degree previous studies have concentrated on pre-service and experienced science teachers' CK in secondary school. For instance, the theory of matter in testing knowledge of secondary chemistry teachers was addressed by Van Driel et al. (2002) while Smith and Neale (1989) pursued a study on teachers' PCK and light and shadows (subject matter). For Hashweh (1987), subject matter was tested on photosynthesis and levers carried out by experienced secondary science teachers. None of these scholars focussed on Grade R teachers or early childhood education.

In Australia, the science curriculum is influenced by teachers' training institutions, notably colleges of education, universities, and schools (Grade K-12). Primary teachers enrol for four years for a primary degree and bachelor of education, whilst core subjects and electives are offered throughout the programme. Science and technology for teaching in primary schools is treated as the core subject, with students attending a one-hour lecture on theory of teaching science followed by one-hour hands-on activities to demonstrate concepts presented in the lecture (Hoban, 2007). However, reports show that, in primary schools, science is the least taught subject, due to absence of science content knowledge, which points to a decrease in teachers' confidence and causes them to neglect teaching of science (Committee for the Review of Teaching and Teacher Education, 2003). In a study by Hoban (2007), nothing was written about TSCK, so their subject matter knowledge and how it influences classroom practice should be explored.

In Jamaica, lack of science content knowledge in teachers has been found to be caused by educational method courses being allocated 30 credit hours and science teacher training at the primary level only nine (Joint Board of Teacher Education, 2014; Robison, 2017). Preparation in Jamaican educational methods courses is given priority at the cost of preparation courses in subject matter knowledge (Joint Board of Teacher Education, 2014). It is evident that this training does not support teachers' preparedness in teaching science concepts effectively, and Södervik et al. (2014) found that teachers enrolled for primary education do not specialise in subjects offered in institutions of higher education and are regarded as generalists. Experimenting and hands-on activities envisaged to enhance trainees' conceptual understanding are neglected as the courses offered in training institutions do not provide sufficient opportunity (Nowicki et al. 2013), and inadequacy of TSCK affects the way teachers deliver science instruction (Oh & Kim, 2013).

2.4. Teachers' Content Knowledge: African perspective

Most teachers in African countries lack content knowledge due to various curriculum reforms and political influences. For instance, an introduction to the Zimbabwe Integrated National Teacher Education Course was established to meet the challenging demands of high enrolments, hence teachers' CK was compromised (Gatawa, 1986). Similarly, in Zimbabwe, in-service teachers on teaching practice were placed in lower level classes since it was assumed that they lacked CK (Makamure, 2016).

South Africa is believed to be lagging behind most of the developing African countries, such as Tanzania, Kenya and Swaziland, regardless of their socio-economic status (Spaull, 2013). Poor teachers' content knowledge is attributed to the geographical demarcation of the country, and Spaull (2013) attests that urban teachers have higher level of content knowledge than their counterparts in the rural areas. This may be due to different levels of access and exposure to facilities and professional development. South Africa has undergone many curriculum reforms, which makes it challenging to some tenants of the recent “Curriculum and Assessment Policy Statement” (CAPS) for grades R-12. It is a challenging issue for teachers who were not trained in CAPS to impart knowledge to learners as only in-service training was provided to them. Rabaza (2016) maintains that topics that address Linear Graphs on interpretation and drawing are not clearly outlined in the CAPS document, which poses a gap in teachers’ content knowledge who were not trained in CAPS as their conceptual attainment is fragmented. Another key factor related to poor content knowledge of teachers was identified by Ramnarain and Fortus (2013) as professional development of teachers in the implementation of science curriculum. Owing to all these, Jita (2016) suggests that teachers need to have a comprehensive CK base in order to be competent in their subject areas.

2.5. Teachers’ Content Knowledge: Lesotho’s perspective

In Lesotho, TSCK is also problematic. Teachers are trained in at least two types of higher education institutions, namely, university and teachers’ training college. Within the only university which offers professional careers in education, the National University of Lesotho (NUL), science education is offered in the faculty of education and students graduate after four years for the degree and four and half years for honours. At NUL, in-service science content for primary teachers is offered four times per week for the duration of two hours in four weeks, which gives a total of 32 hours per course. The method of teaching science in this university is questionable. For instance, Rogoff, as cited in Stigler et al. (2010), argues that proper training nurtures specific cognitive skills linked to classroom activities. Different contexts contribute to TSCK but whilst teachers graduating in this institution happened to teach Grade R teachers while they were in high school and/or in primary, the question remains as to what quality of science content knowledge they offered preschool teachers. This speaks to different modes of delivering content with differences in opportunities and curriculum exposure. Time factors influence how the content is instilled, as that in use for learning has been argued to have an effect on the competence of pre-service teachers (Schmidt et al., 2011).

At the Lesotho College of Education (LCE), science as a subject is offered in three folds, namely, secondary, primary and early childhood. The secondary trainee teachers elect science subject as their major course while their counterparts in other sectors enrol for it as part of their certification courses. Secondary and primary programmes are pre-service diploma courses with a duration of three years full-time, while the early childhood sector offers a two-year certificate to preschool teachers on a part-time basis. At LCE, one credit hour equals two hours. The content in science elective course (secondary fold) weighs 19 credit hours (in Biology, Chemistry and Physics) while in primary fold general science content weighs 16 credit hours. In Early Childhood, a course in science carries the load of two credit hours per week in four weeks (LCE, 2020). Based on the above, it is evident that science content is given relatively little time and teachers trained in this institution have a varying level of content.

The content offered for the pre-school teachers at the LCE includes:

1. The young child, self and Science environment
2. Science processes in the ECCD context
3. External body parts, their uses and care
4. Human body and five senses
5. Audio-visual material development and active learner participation in ECCD science class through range of methods
6. Children’s plant/animal environment: their parts, uses, simple classifications, dangers of some plants and care
7. Lesotho climatic conditions and their effects in our society
8. Physical composition structures - naming and features
9. Simple machines and tools: construction and uses (Lesotho College of Education, 2007:18)

The Lesotho MoET committed itself, inter alia, to improving the quality of basic education by implementation of various strategies for teaching science (MoET, 2011). The main goal of the Integrated Early Childhood Care and Development (IECCD) policy is:

> …to provide all Basotho children with high-quality, participatory and sustainable IECCD services from preconception to five years of age, thus ensuring children would achieve their potential in all developmental areas, be ready for school, and become productive citizens of the Kingdom (MoET, 2013:17).

Therefore, teacher training should align with the MoET’s policy to equip learners with scientific skills that would shape them into better citizens.

The IECCD unit in the Lesotho MoET has developed learning standards and expectations that have to be addressed in early childhood areas that address science concepts in schools. This offers preschool learners opportunities to have foundational competences in science because they explore scientific concepts in their everyday interactions with the world. Despite the existence of the learning standards and attention to science curricula, little is known about the relationship between teachers’ science content knowledge and its application in the classroom. Literature suggests that TSCK, when dealt with in other countries, is stressed mostly in the context of middle and high school or even in higher education, with little if any focus on early childhood levels (Deniz & Adebelli, 2015; Diamond et al., 2013).

Much remains to be understood regarding the science knowledge of Grade R teachers and how it influences their classroom practices. Whilst a similar study was conducted concerning preschool CK and classroom practice by Kallery and Psillos (2001), their investigation was different from this study in that it focused on teachers’ content knowledge in relation to answering pre-scholars’ questions in the classroom.

2.6. RELATED LITERATURE

This section reviews literature related to the research questions.

2.6.1. The impact of content knowledge on science teaching

Some authors agree that science is dominant in many spheres of life, irrespective of whether it is studied at the higher or lower level (Davies & McGregor, 2016; Harlen & Qualter, 2014). Most human decision-making is based on scientific thinking or reasoning, for instance, in deciding what to wear one may look at the weather through the window. Many products that are used at home are the result of scientific research. To avoid wasting energy such as electricity and sustaining resources such as water emphasis of developing scientific attitudes is needed through science lessons. Davies and McGregor (2016) argue that if some ideas are omitted or misinformed to preschool learners, later development will be obstructed. Moreover, due to the rapid changing scientific transformation in technology, being scientifically literate is not an advantage but a necessity (Harlen & Qualter, 2014).

In many research studies, good science teaching has been linked to the level and quality of teachers' possessed CK. For instance, at pre-school level, Akçay (2016) noted that poor CK leads to the teachers' low self-confidence for teaching science, concurring with a study on structures of teachers' knowledge by Bartos and Lederman (2014). The latter wanted to understand how science knowledge influences classroom practice and their sample consisted of four physics teachers who responded to questionnaire and subsequent interview. Their findings showed inadequacy in teachers' knowledge of science that consequently affected their classroom practice negatively. In South Africa, Taylor and Booth (2015) conducted a study in which eight educators trained in the same institutions with equal opportunities to learning were studied. Due to the exposure of the teachers it emerged that teacher training can change teachers' beliefs and orientations to science learning.

Other researchers, such as Khourey-Bowers and Fenk (2009), claim that teachers with broad and deep understanding of the subject matter better provide their learners with best learning opportunities and that makes science learning enjoyable. Thus, knowledge of subject matter is cited by Vosniadou (2007) as an additional dimension teachers need to develop in order to promote learners' conceptual awareness and engagement in learning. Demirdöğen et al. (2016) delve into a case study in which they explored the improvement of chemistry teachers' science base knowledge, their orientations, understanding of learners and assessment. Through constant analysis of pedagogical content knowledge they acknowledged the power of professional development given to teachers to improve their science. The question remains as to whether participants in this study received any form of professional development.

Children enjoy understanding new concepts when they experience the environment around them, for its wonders and richness make sense to them in a compelling way for the learning of science (Guo et al., 2015). This applies to "stimulating interest in learning science through relating it to familiar situations and objects helps to develop realisation of the widespread consequences of its applications, locally and globally" (Harlen & Qualter 2014:11). The key element in helping children to make sense of what they are doing is by letting them play (Guo et al., 2015; Palaiologou, 2016). According to Trundle and Saṣkes (2012), young learners are capable of learning science concepts as prescribed by learning standards. For instance, when children are learning and investigating how objects float or sink, they are learning systematic approaches to problem-solving that they can apply in their lives. According to Morrison (2015:360), when learners have "a love of science and ability to think and express themselves scientifically," the world will not be confronted with cases whereby preschool learners get into difficulty after playing near dams, rivers, and pools.

2.6.2. Effective science classroom practice

The best classroom practice in science learning is constituted on inquiry-based learning (Dickson, Kadbey, & McMinn, 2015). Rooted in the work of John Dewey

(1859-1952) and embraced by Bruner (1961), inquiry-based learning has since been regarded as the best method for teaching science (Lazonder & Harmsen, 2016). Dewey recommends that learners be taught how to think and act scientifically rather than memorizing information (National Research Council, 2000). Ireland et al. (2012) concur with the issue of inquiry-based learning by narrating how it plays a major role in sensory and experienced learning. This means that learners will be hands-on in activities in the classroom, inquiring and asking questions. Therefore, inquiry-based learning is realised the moment learners construct meaning, ask questions and solve problems in the classroom (New School Model Teacher Guide, 2013: 21). “Science-as-practice perspective brings together content knowledge and process skills in a manner that highlights their interconnected nature” (Harris & Rooks 2010: 229), which is believed to provide learners with opportunities to be independent, inquisitive and autonomous enquirers.

Good classroom practice is characterised as engaging students in inquiry, ideas and evidence in such a way that teaching and learning will help learners to develop and extend what they are doing in a meaningful way (Setiawan & Siayah: 2020). This has been well articulated as “children are encouraged to explore their learning actively through creativity and problem solving, [and are] engaged in purposeful practice as they move towards independence” (American Distance Education Consortium (ADEC) New School Model Teacher Guide, 2013:8).

The science classroom is more learner-oriented than teacher-oriented as it is expected that teachers are effective and passionate with teaching science content and are able to engage learners in a constructive manner (Setiawan & Siayah: 2020). Teachers’ effectiveness is displayed in their ability to fabricate what they know to the learners and create opportunities for inquiry learning (Spaull, 2013). Effective science learning and classroom practice is defined by Staver (2007:12) as “using guided inquiry teaching strategies that lead learners to continue developing and modifying their knowledge.” This could be realised when learners take control of their learning with little guidance from the teachers. Behind any science classroom, the ideology is that teachers assist learners to be problem-solvers. Scholars such as Palmer et al. (2015) and Kadbey et al. (2015) have noted that learner's prior knowledge, classroom environment, resources, opportunities and teachers' orientation to teaching influence classroom practice. All that would be possible as long as teachers are implementing inquiry-based learning effectively in their teaching space. Their science CK and content-specific strategies would help them to identify students' misconceptions, promote inquiry, and encourage group work as well as problem solving skills (Appleton 2003; Osborne et al., 2003).

2.6.3. How science teachers acquire knowledge

Teacher knowledge is acquired formally and informally through craft, systematic and prescriptive knowledge (Kennedy, 2002). These forms are discussed below:

a) Craft knowledge

Sometimes referred to as 'practical knowledge' (Carter, 1990), craft knowledge is acquired through daily experiences of teaching and learning between learners and the teacher (Doyle, 1990). It has been defined as "integrated knowledge that represents teaching practice" (van Driel et al., 1998:678). The accumulated wisdom is codified by Shulman (1987:11) as "the wisdom of practice itself, the maxims that guide the practices of able teachers." Pre-school teachers develop this kind of knowledge through practical scientific activities with learners in the classroom. It is asserted by Beijaard and Verloop (1996) that craft knowledge encompasses knowledge gained from continuing school activities, long confirmed by Clermont, Krajcik and Borko (1994) that experienced teachers demonstrate more knowledge than novice counterparts due to their experiences. Also, Rice and Kitchel (2017) suggest that teaching experience has some effect on teacher CK. It is expected that pre-school teachers will have craft knowledge that will inform their practice in helping learners understand the subject matter and therefore participate fully in the classroom. Because of its practical nature, Grade R teachers with possession of craft knowledge are expected to solve problems with ease.

b) Systematic Knowledge

Systematic Knowledge is mainly acquired through pre-service and in-service teacher training interventions (Utz & Aubert, 2008), in which in this context pre-school teachers are expected to develop skills and knowledge of subject matter to be taught in the classroom. Although Gess-Newsome and Lederman (1993) diverge on the topic, they suggest that college structured courses contribute to knowledge of subject matter but their argument is that for novice teachers that is of little help because of complicated classroom content that teachers face when they arrive at the field. They suggest that teachers' knowledge would be more coherent when they had gained more experience. However in one study conducted by Clermont et al. (1994) the conclusion was that teacher knowledge could be enhanced during intensive short-term or skill-oriented workshops. Thus concurs with Iserbyt et al. (2017), who found that professional development workshops benefit teachers. Therefore, teacher training institutions provide systematic knowledge in which teachers are expected to acquire the intended knowledge so that it serves as a prescription in guidance of their work. Participants in this study acquired their science content knowledge through in-service teacher training interventions. I am expecting them to display that knowledge when they are teaching.

c) Prescriptive knowledge

Acquired through institutional policies (Kennedy, 2002), prescriptive knowledge has an element of command within its structure, leading teachers to follow its policies, rules and procedures as prescribed. Grade R teachers in Lesotho have to use curriculum guides from which concepts to be taught are drawn. This source of knowledge is however used by choice within schools as policies, curricula and study materials change regularly. Even if this is the case, each school has prescribed policy and curriculum that should be strictly adhered to. This prescription answers the question of what should be taught to or learned by the students (Kennedy, 2002).

2.6.4. Learner- oriented practice versus teacher-oriented practice

The two divergent approaches to teaching science discussed in this section are teacher-oriented and learner oriented practices. A mixture of this two approaches is referred to as a hybrid practice. These approaches guide this study in observing teachers' activities and learners' activities as they emerge in the classroom.

a) Learner-oriented practice

In this approach, learners are expected to be active participants in construction of their own learning. Literature indicates that several terms are given to learner-oriented approach, including "student-centred", 'inquiry-based", and "discovery-based" (Loyens & Rikers, 2011). Learner-oriented practice is defined "as an active process in which learners are active sense-makers who seek to build coherent and organised knowledge'' (Mayer 2004:14). The learning environment in learner-oriented approach supports learners by constructing their own knowledge (Baeten et al., 2013). When a classroom operates with student-centred instruction there is a shared focus between the teacher and the learners. The teacher and the learners interact between themselves instead of listening to the teacher alone and learners are expected to show much passion and responsibility for their learning (Godec et al., 2018; Lawson & Lawson, 2013; Hampden-Thompson & Bennett, 2013) because if opportunities are created for their learning, the struggle to understand concepts taught in science classrooms would be eliminated. However, in China, Sun et al. (2014) found out that learners were provided with limited opportunities for participating in science class because teachers were dominant in class talk. Dominance in class indicates that teachers spent most of their time talking and directing what should be done in the classroom.

In a learner-centred classroom, a group or pair of learners would be seen working together on a task or project (Brown, 2010). The pair will help each other to accomplish the set task. At that moment, teachers work as facilitator and coach of the learning process because their roles allow for learners to ask questions and draw conclusions. They are supposed to 'chip in,' when learners are stuck with some hints but without giving learners the final answers. Constructively, teachers create learning activities that are more relevant to the learners' needs and contexts, such that learners will be engaged in discovery and critical thinking processes (Cheng, Chan, Tang, & Cheng, 2009). According to Michaels et al. (2014), for learners to develop a deep understanding of scientific explanations of the natural world they need sustained opportunities to work with and build on the concepts that support these explanations so as to understand the connections between concepts and real-world situations. Yet to be discovered by this study is how teachers use their knowledge to stimulate learner engagement in the class.

b) Teacher-oriented practice

Commonly used in teaching and learning, teacher-oriented pedagogy has its own problems and advantages. For instance, it favours learners who learn by listening, thus encouraging approaches by teacher authority whereby information is ‘dished out’ to learners (Schreurs & Dumbraveanu, 2014). The teacher uses her or his expertise in content knowledge to help learners acquire skills and knowledge. Amongst various names referring to teacher-oriented pedagogy are ‘traditional,” “teacher centred” and “subject centred” (Mascolo, 2009). Some scholars perceive teachers in the teacher-oriented approach as transmitters of the knowledge, while learners are mere recipients of what teachers are telling them (Chan & Elliott, 2004; Loyens & Rikers 2011). Students pin their hopes and expectations on the teacher, who does not consider learners’ previous experiences or background information. They expect learners to memorise information without understanding it (Mascolo, 2009).

Tomlinson (2014) suggests that when teachers’ practice is teacher-oriented, learners are denied opportunities to engage actively and interact with others and the environment of teaching and learning. In Lesotho, Raselimo (2010) and Nketekete and Motebang (2008) found out that teacher-centred pedagogy is common practice. For learners to develop a deep understanding of scientific explanations of the natural world they need sustained opportunities to work with and build on the concepts that support these explanations and understand the connections between concepts (Michaels et al., 2014). Scientific inquiry as explained before emphasises that learners should be given opportunities to construct their own learning. Are Grade R teachers in Lesotho provide opportunities for science inquiry in their classrooms?

c) Hybrid approach

Although the above sections discuss two divergent approaches, a mixture of both have been noted by Donnelly et al. (2014), seen in constructivist learning environments when teachers practice elements of inquiry-based classroom coupled with traditional practices. However they discovered that even if learners could be given the opportunity to execute tasks, teachers remain predominant in monitoring completion of tasks over task understanding by leaners. Teaching and learning is a two-way process as the role of the teacher is to direct learning by giving guidance and support. This study is yet to find how teachers' science content shapes their classroom practices.

2.7. Teachers' science content knowledge

This section discusses how teachers acquire their science content knowledge through various means like exposure, qualification and training.

2.7.1. Exposure for science CK learning

In this study, teacher exposure to teaching science is measured by the amount of content and pedagogy to which teachers are exposed for their qualification. The qualification can be an education certificate, diploma, junior, master's or doctoral degree. In order for teachers to carry out their classroom activities, a teacher education programme could assist in this regard (Mogan et al., 2009). According to Lynd (2005), programmes aimed at teacher training help to develop knowledge, skills and attitudes. In-service and pre-service teachers are formally exposed to content knowledge and pedagogy in education programmes. Pre-school teachers who went to the college of education would thus be in a position to deliver content acquired during their training.

Some countries, such as Finland, advocate a high-quality education system thereby investing in the profession of teachers of whom all hold at least a two-year master’s degree that includes both a CK as well as a strong pedagogical preparation (Darling-Hammond, 2017). Also, at the heart of the Finley education system, is research and practice. Teacher recruitment in countries that are focused on building a strong teaching profession supports their candidates. In Singapore, Darling-Hammond (2017) indicates that a bonding agreement is signed between the government and the candidate with the view that comprehensive material inducements, such as living stipend, tuition, books and laptops, would be covered if candidates worked for the government for at least three to five years. The demand on the teaching profession has put Canada in a position whereby it had to recruit teachers, considering their grades, engaging interviews and portfolios as well as volunteering service (Darling-Hammond, 2017).

As much as recruitment of teachers of high calibre is an issue in influencing teachers’ CK and pedagogy, priority in recruiting teachers in Lesotho is only by chance. When compared to other professions, education entry requirements in institutions are fewer. For instance, at the National University of Lesotho (NUL), where the education profession is offered amongst other professions, prospective students who wish to enrol for Bachelor of Science in Education (B.Sc. Ed.), a four-year programme, has the following requirements:

“students must have:

- Sat for a minimum of six (6) subjects in Lesotho General Certificate of Secondary Education examinations
- Obtained a B grade or better in Mathematics
- Obtained a C grade or better in Biology or Physical Science
- Obtained a C grade or better in English Language
- Obtained a C grade or better in one other subject

- Obtained a D or better in any other two subjects'' (NUL 2020: 5-6 of 45).

The same credentials apply to the Bachelor of Science (BSc.) - BSc. General - BSc. Computer Science - BSc. Information Systems - BSc. statistics requirements apply as above. However there is an addition of ranking:

"Students will be ranked according to the total point score using the following criteria:

- Mathematics.
- One Science subject (Biology or Physical Science).
- Second Science subject or English Language (whichever is better).

Due to the high number of applicants, students will be admitted on merit" (NUL 2020:19-20 of 45).

The above shows that science education is not considered as highly as other science courses in this university. The same teachers who obtained a teachers' degree in science at NUL are the same who happen to teach pre-school teachers science in high school. The question arises as to whether the ability of content delivery at their schools is influenced by their high school teachers such that they are able to recall what they learned that could help answer learners' inquisitive questions.

As in other countries, there is no form of attraction for candidates to join the teaching profession. Even the Lesotho National Manpower Development Secretariat, the body responsible for supporting students in various fields of education, allocate funds using the list from the university's accepted candidates. Available funds could in a way influence prospective students to join the teaching profession because they could not be accepted elsewhere. Teachers' science teaching self-efficacy might positively be influenced by training institutions because there are opportunities for learning information regarding content in science, learning skills and strategies for teaching, being hands-on in activities, working in groups and even taking part in classroom discussions (Palmer et al., 2015). In institutions, trainees copy teacher trainers by observing how they model good teaching behaviours including passion and humour. Lemmer and Badenhost

(1997) suggest that teachers should be well-trained and knowledgeable because it is through them that a learner will succeed and they are in the position to see signs and symptoms in at risk learner.

2.7.2. Teacher qualification for teaching science

A teaching qualification is regarded as an academic award given to the student after completion of certain courses from an authority body such as the government, college or university. The teacher qualification permits a teacher to teach learners from pre-school to high school, depending on the qualifications from training, for example, certificates, diplomas and degrees in education.

Several studies have highlighted that the more undergraduate science teachers have learnt, the better learners' performance (Kahan, Cooper & Bethea, 2003; Kessel, 2009). Although this exhibits the contribution of teacher qualifications to students' achievement, Kessel (2009) noted that the issue of qualification regarding achievement mostly works for advanced teachers. However, researchers need to consider the qualification and its relevance to the profession. For example, a difference between a degree and a diploma in science may be negligible when teaching lower levels such as Grade R. Teachers may possess a qualification but lack the necessary content knowledge for teaching science. This means that whatever level, which ever qualification, what remains is how teachers teach concepts with the knowledge they have to solve learners' problems.

In Australia one has to meet the following to become an early childhood teacher:

- "A four year Bachelor of Education (Early Childhood, Kindergarten to Year 7 or 0-8 years Early Childhood Education/Childcare)

  or

- A minimum of a three year degree followed by a one year Graduate Diploma in Early Childhood Education or Master of Early Childhood (Department of Education. Teaching qualifications – Working in public education" (The Department of Education (Australia). 2018).

Most universities in South Africa offer a degree in Pre-school and Foundation Phase, usually obtained after four years. Subject courses and pedagogical methods, as well as teaching practice, are presented in those four years. In contrast, Lesotho's pre-school teachers obtain a certificate after two years in which a science course is taught for four weeks in an in-service programme. Another issue of interest is that Lesotho teachers are deployed to teach grades for which they are not qualified, for instance, primary teachers may go on to teach pre-school learners, which could be a challenge when delivering content to learners. During their time in college, normally in the first year, pre-school teachers are equipped with theoretical concepts on how to deliver subject content to the third party. They are taught not only the methodology of content delivery but also the subject matter knowledge to raise their knowledge above that of the students they will encounter during their teaching (Santagata et al., 2007).

School science is cited as teachers' main source of CK (Arzi & White, 2007), essential in confronting their misconceptions of any science topic, or those embedded in school science knowledge and practices. Therefore, the authors suggest that teacher education has a part in refining misconceptions related to topics taught in school science.

2.7.3. Training of Grade R teachers in Lesotho

Training of teachers can take various forms, for instance, a pre-service course taken before a teacher can be qualified. Another is an in-service programme which is designed for practicing teachers and the induction programme which caters for teachers in their first years at school as a form of support. Duration of training in these forms of preparing teachers for professional roles is not the same. A pre-service course takes longer than an in-service one. Skills, knowledge and attitudes acquired in teacher training are needed as teachers have to display competency desired in the classrooms (Lynd, 2005), hence, teachers may also be able to use that knowledge in assisting learners to acquire the knowledge of floating and sinking conception for their own understanding in the science classroom. Kelly and

Tannehill (2012) emphasise that college acquired knowledge contributes to their CK because the primary goal of the college is to develop teachers' theory and practice.

Strong emphasis on deepening teachers' understanding of science content is expected to be delivered in teacher training institutions (Mogari et al., 2009). At the LCE, preschool teachers take science as one of the courses offered over four hours in four weeks. The programme is in-service and in science is regarded as a general course with floating and sinking one of the topics taught. With the new diploma course which is introduced in the year 2020, the Science course is offered within six months, focusing on Biology, Physics and Chemistry. The 2020 ECD teachers cohort do not form part of this research as the study is undertaken before they can graduate. The objective of this study is to explore the science content knowledge of Grade R teachers in Lesotho with respect to the science concepts and their influence on classroom practices.

2.7.4. Conceptualising floating and sinking

Floating and sinking are concepts commonly presented in an early childhood classroom (Hsin & Wu, 2011). It is assumed that preschool learners will say that objects float in water if they are significantly seen above water, while they sink if not seen above water. According to Wiser and Smith (cited in Zoupidis et al., 2016), students who have perception-based understanding of density understand that "an object is heavy" when they mean that "it is heavy to be held." To them density and buoyancy are abstract to comprehend and such students would say "an object sinks because it is heavy" while the meaning behind that is "an object sinks because it is heavy for its kind of material" (Wiser & Smith, as cited in Zoupidis et al., 2016). This means that students focus only on objects and not on materials that made them. However, Hadzigeorgiou (2015) argues that it is not all children who think that light objects float and heavy objects sink, rather some predict that "light objects will sink because they can move easier through the water, while heavy objects find it difficult to reach the surface of the water […] so they either reach the bottom, by moving slowly, or will remain on the surface like big boats."

Several studies have focused on how young learners understand the concepts "float and sink" (Dentici et al., 1984; Hadzigeorgiou, 2015; Hsin & Wu, 2011; Havu-Nuutinen, 2005). This study aims to understand how teachers' science CK influences their practice on selected science concepts, "float and sink." It is yet to be found if learners believe that objects sink because they are "heavy" due to their limited understanding of density as a ratio quantity, and what will the teachers say and actually do in the classrooms about that? When this is the case, teachers should come up with a causal linear reasoning explanation in which objects and water densities are compared.

Scholars debate whether it is possible for the learners to judge whether an object can float or sink in water, because comparing density of the object and density of water is difficult for their level. For Piaget (2001), children would understand the concepts when they are in their late childhood (around age 9). Grounded on this suggestion, Hsin and Wu (2011) propose that young children should focus only on manipulation of objects rather than explain why objects float or sink in water. There is an argument, however, that young children already have developed some ideas about density and buoyancy, therefore the idea of scientific explanation of why objects float or sink should be treated with care. According to Hsin and Wu (2011), with a little guidance young children can go beyond the process of manipulation to a stage in which they can explain why objects float or sink if teachers are able to engage effective instruction. One example could be to direct their attention to using "material kind" to help them understand concepts of weight and density (Smith et al., 1985). The present study is not against the aforementioned debate as my interest is to find out whether pre-school teachers' CCK can help them explain, if needed to by the learners, why objects float or sink.

The curriculum guide used by Grade R teachers in Lesotho gives guidance on what science themes teachers can teach. The themes emphasise ways in which young learners can learn and discover the world around them. Floating and sinking is one of the sub-themes presented under the theme 'water' found in the curriculum guide (MoET, 2011). However the floating and sinking theme which is the topic of focus in this study is not explicitly described. One can wonder as to how much information regarding the sub-theme the teacher is able to transmit to the learners. Table 2.1 below shows an extract from the curriculum guide for reception classes (Grade R).

Table 2.1: An extract taken from the curriculum guide for reception classes (Grade R)

Theme	**Sub-theme**	**Suggested activities**	**Skills expected**	**Suggested materials**	**Assessment**
Water	Sources of water Uses of water **Floating and sinking** Formation of rainbow colours	Teacher asks children to tell places where to get water from and its uses. Teacher provides children with objects to experiment **floating and sinking**	Experimenting Observing Exploring	Pictures, posters, Tins, Straws, Soap, Water	Observation Checklist

An extract taken from Ministry of Education and Training Reception Class Guidelines (2011)

The purpose of the Reception Class guideline is to guide Grade R teachers with the content that should be taught in Grade R classes. The question remains as to how the guidance is guiding to the teacher. How about if the teachers do not have enough content? What content would be addressed during floating and sinking activity? Teaching of this topic will depend on teachers' science content knowledge and if such knowledge is not properly located, the result could be drowning in a sea of names, facts and inappropriate connections (Greenwood, 1996). The following section explains some of misconceptions made by the teachers about floating and sinking.

2.7.5. The floating and sinking misconceptions

Mistaken “scientific” knowledge may be referred to as “misconceptions”, “misunderstanding”, “alternative frames” or “alternative conceptions” (Arslan, Cigdemoglu & Moseley, 2012). In this study, the term misconception is used to explain misconstruction of scientific concepts related to floating. Literature suggests that explaining the concepts of floating and sinking phenomena to children is associated with an abstraction that arises from conceptual understanding of density, pressure and pressure force, buoyancy and buoyant force, amongst other things (Zoupidis et al., 2016). The most common conception regarding floating and sinking objects is rooted in the idea that objects sink because they are heavy and float because they are light (Kiray et al., 2015). For instance, many students would expect that a large piece of wood would sink while a small piece of iron would float (Leuchter et al., 2014). In determining whether the object will float or sink a comparison between the density of the object and that of the liquid should be made (Kawasaki, Herrenkohl, & Yeary, 2004).

Another misconception is associated with the object’s shape as many learners would decide that an object will float because its shape is similar to that of a boat or ship. Students assume that when objects are flat or empty they will not sink in water while those with hollows or holes will (Havu-Nuuiten, 2005). Literature shows that students regard that an object will float or sink due to the way it is dropped in water (Duit & Treagust, 2003), thinking that when an object is dropped in water by using its sharp edge it will float (Kiray, 2010). Furthermore there is a misconception that hard objects sink in water while soft objects float (Havu-Nuuiten, 2005). In addition, learners think that rigid objects sink while soft objects float (Yin, Tomita & Shavelson, 2008).

Another misconception is related to density. It is assumed that “the change in density of a liquid induces changes in buoyancy of an object, and the density of an object hanging in a liquid is equal to a floating object’s density” (Unal, 2008). Another misconception is related to force, as students believe “that when the volume of the liquid decreases, the buoyant force decreases, too, if the greater the floating part of an object, the greater its buoyancy" (Çepni& Sahin, 2012). These misconceptions would perhaps affect students' understanding of sinking and floating concepts. With the knowledge they bring to school, misconceptions need to be eradicated because if faulty ideas remain unchanged and unchallenged from childhood they will result in recycling between generations of teachers and students. The question remains as to how much CK Grade R teachers have in relation to floating and sinking misconceptions that they could use to eradicate learners' misconceptions. Russell- Bowie (2012) noted that when teachers have misconceptions they talk longer and more often, and mainly pose questions of low cognitive level. Another concern is that insufficient SCK put teachers in a position whereby they would teach inaccurate content and reinforce misconceptions.

2.7.6. Progression and integration of concepts "float and sink"

In this study, 'progression' refers to what can be learnt by the learners when they are in higher grades that are related to floating and sinking, while 'integration' means integrating floating and sinking concepts with others in different learning areas. Several concepts have been noted to have a link to floating and sinking and could be taught as foundational topics or the ones learners will learn when they are in upper grades. For example, the concept of "material kind" could be used as a foundational concept that helps in understanding of densities. Hardy et al., (2006) explains that when such concepts are used in relation to each other, misconceptions associated with them would be eliminated on the assumption that learners will observe the behaviour of objects made with same materials but with different mass and volume. With appropriate instructions provided to Grades 3 and 5, the concept of volume and density could be taught respectively (Lehrer, Jaslow & Curtis, 2003). According to Hardy et al., (2006), in order to understand fundamental reasons for sinking and floating learners should understand such complex concepts as resolution of forces, that is, buoyancy and gravity, water pressure, properties of matter, density, relative density, and related concepts. Paik et al., (2017) agree that the concept of force could be introduced to middle school curriculum in relation to floating and sinking covered in lower grades. However, Yin, Tomita and Shavelson (2014) are worried that those concepts are not appropriately dealt with in elementary and middle school curricula.

Integration of floating and sinking concepts is made across other subject areas as it is explained by Howe (2009) that in learning, learners use their language as a tool for thought to try to understand how they learn science. For example, in the context of floating and sinking, learners will name objects that are gathered to be used for manipulation.

2.7.7. Scientific process skills

Teachers' specialised content knowledge is demonstrated when they are able to take learners through a process of science that will enhance their scientific skills. When learners are given a chance to practise, even those in the foundation phase will develop scientific process skills which involve observing, comparing, classifying, measuring, experimenting, and communicating (Campbell & Chealuck, 2015). Due to their developmental ability, small learners might not know that they have certain skills, however, it might be expected that a knowledgeable teacher will help them to acquire those skills in order to prepare them for formal school. It is the choice of the teacher to focus on one or more skills at the time (Campbell & Chealuck, 2015). For instance, while teaching the concepts of floating and sinking, a Grade R teacher may want learners to classify objects according to floating and sinking without taking them through the process of finding out which objects might float or sink which would require them to infer, predict, experiment, observe and draw conclusions. Beaumont (2010) adds that generic skills such as estimating, counting, generalizing, collaborating, recording and problem-solving should not be overrated as they are also deemed important in the teaching and learning of science concepts.

2.8. Teaching science concepts (floating and sinking)

Teaching science concepts involves a number of important steps. They are discussed below.

2.8.1. Planning and Presentation

Considered as a guide that helps a teacher during teaching and learning, the expectation is for the teacher to have prepared a plan before going to class. Ghanaguru et al. (2017) define a lesson plan as a design or self-contained mapping which gives a teacher a sense of direction while teaching in the classroom. It may comprise an introduction of the topic, learning objectives, teaching methods, teaching and learning materials, activities, assessment and conclusions, amongst other things (LCE Teaching Practice Guidelines, 2019). By putting these elements together in a lesson plan, teachers ensure that the planned activities help students meet their educational goals, allowing for efficient use of classroom time and keeping the lessons on track regardless of distractions. Without having a well-thought-out plan in place it is easy for teachers to get off track with the class and miss out on educational targets.

However, planning a lesson to some teachers, especially the ones who are not worried that they will be checked by their supervisors, poses a problem (Thornbury, 1999; Bhargava, 2009). The most obvious concern of the scholars is that written lesson plans do not match the actual teaching in the classrooms (Ghanaguru et al., 2017). Brickhouse (1990) found that teachers claim to have observed and adhere to their planning, which is not always the case when they are observed. Probably, this is due to their low level of subject matter which affects the way they plan and implement it (Tairab, 2010; Justi & Gilbert, 2002; Osborne & Simon, 1996). The Grade R teachers who were trained at the LCE have been introduced to the development of a good lesson plan before going to teaching practice (Lesotho College of Education, 2019). Nonetheless, teachers have a tendency to deviate from what they learnt in their training institution, thereby “going with the flow” of what is happening in the fields and leaving behind the gist of what should be done. Below I attempt to explain the depicted components of a lesson plan based on literature review.

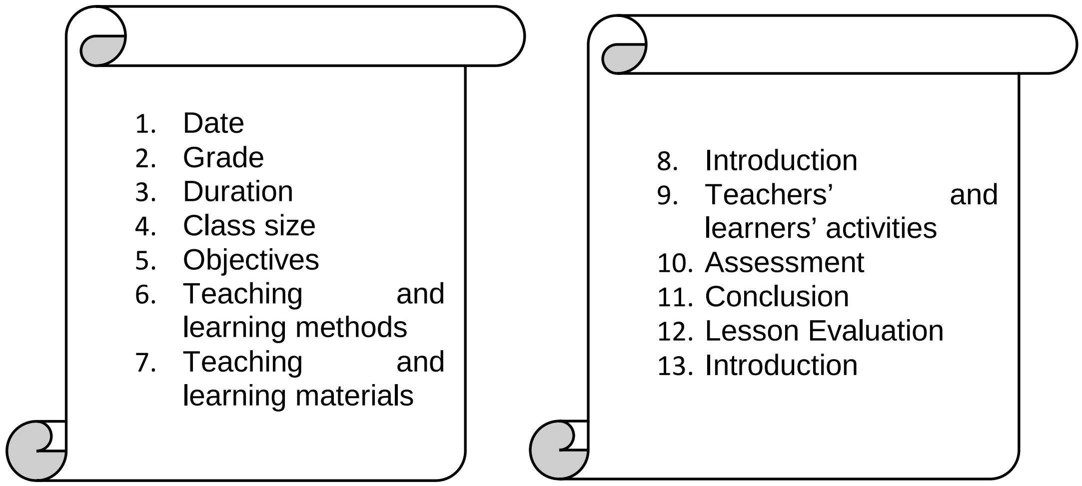


Figure 2.3: A diagrammatic representation of lesson plan components for Grade R.

2.8.1.1 Lesson objective(s)

The learning objective specify the concepts learners are supposed to learn by engaging activities and skills to be developed during the lesson (Reed, 2012). The first step in daily lesson planning is formulation of clear, well written objectives. Formulation of the objective should demonstrate the features that should be specific, measurable, achievable, realistic and time-bound (SMART) (Johnson et al., 2011). The objectives assist in selection of appropriate activities, what to assess and conclude (Farrell, 2002). The pitfall that faces many is the construction of behavioural and measurable indices. When writing learning objectives, Reed (2012) suggests that Bloom's Taxonomy could be referred to as a right place to find many action verbs that will determine whether the wording is oriented toward a lower or higher order level of cognition. Verbs such as 'understand,' 'appreciate,' 'study,' 'learn' are difficult to assess and measure and therefore should be used with caution. Despite explanations of lesson objectives given above, elements of teachers' objectives not addressing teachers' instruction was observed by Barendsen and Henze (2019). The question remains as to whether Grade R teachers in Lesotho would be aware of using SMART objectives that assess what is intended to measure.

2.8.1.2. Teaching methods/strategies

Teaching methods and/or strategies include ideologies and methods used by the teacher during teaching and learning. These methods are influenced in part by the content to be taught and the level of the learners being taught. Due to dynamic nature of the classroom environment, with learners of various backgrounds and capabilities, a teacher should not apply a ‘one size fits all’ resolution to inspire learners in the classroom. There are a number of teaching methods or learning strategies, hereafter, I discuss the methods commonly used by most pre-school teachers: Questions and answers, demonstration, discussion, group work, singing and dramatizing.

a) Question and Answers

Socrates, an ancient philosopher, showed much interest in learner-centred approach such that he argued learners were not “tabula rasa” or “empty vessels,” an argument based on the idea that learners come to class with something in their minds that could be activated by the teacher when asking questions (Gillies & Nichols, 2015). The commonly known teaching method called “questioning and answering”, was named after Socrates and was called “Socratic.” Questions can be asked by both the teacher and the learner with the purpose of understanding the concept. Questions should be asked in a manner that allows for elicitation of information. Grade R teachers should consider learners’ background information about floating and sinking objects and drive their learning in such a way that their schemata would be activated and new knowledge acquired. However, Inamullah et al., (2008) noticed a two-thirds law suggested by Flanderl existed in most teachers’ classroom, whereby teachers would occupy two-third of the lesson talking while learners actively engage in only one-third. This reduced learners’ inducement to construct their own knowledge.

b) Demonstration

Demonstration is a useful method of teaching because it increases students' understanding and retention as the demonstrator shows them what to do first before embarking on an activity (McKee, Williamson, & Ruebush, 2007). The teacher imparts knowledge by showing the learners what to do. For example, a pre-school teacher may teach floating and sinking concept by performing an activity that s/he wants her learners to do on their own. Basheer et al. (2017) embarked on a study in which they investigated whether using demonstrations by the teachers considerably improved learners' comprehension of redox reactions linked with control group colleagues who were not familiar with demonstrations. They found that the control group's performance was not statistically significant to the experimental group's achievements. They concluded that demonstrations could be a useful method for enhancing learners' motivation to learn and comprehend some chemistry concepts. In this study it is expected that teachers would use a demonstration method to facilitate learning. When demonstrating an activity or an experiment to the learners they are motivated to learn and their memory retention is raised because what is demonstrated connects them to the real-world and that could help them when they apply the knowledge they have learnt.

c) Discussion

Discussion is also one of the teaching methods which encourages collaboration in a classroom. Gall and Gillett (1980) suggest that discussion methods are a variety of forums for open-ended, collaborative exchange of ideas among a teacher and students or among students for the purpose of furthering their thinking, learning, problem-solving, understanding, or literary appreciation. Discussion can be teacher-led or learner-led. During discussion, learners in the classroom are given equal opportunities to put forth their views in a democratic way. Most often, a discussion is facilitated by a teacher, especially in early childhood learning. A teacher can probe the learners' understanding, paraphrase the information received, and ask questions that encourage critical thinking, such as, "What makes a plastic float in water?"

d) Group work

Group work is another teaching method used in the classrooms. Learners are given chance to work together in small groups or pairs sharing information on the topic of study. Ford and Forman (2014) contend that learners collaboratively construct knowledge and talk about their scientific activity. This “give and take of talk” is believed to add value in learners’ skills of reasoning as they talk, take turns and come to a consensus (Mercer et al., 2009). Similarly, Gillies and Boyle (2010) agree that talk enables learners to establish small cooperating groups in which they understand how to put aside their differences so that they can share ideas, work collectively to construct new knowledge. When doing so, Novilia et al. (2017) add that learners who are denied an opportunity to work as a team are denied the opportunity to improve on their problem-solving and communication skills.

e) Singing

Singing is a learning technique that may not only enhance learners’ performance but also can be fun to young learners, argued by Blythe (2015) who draws on neuroscience to unpack the worth of singing to or with children in relation to content-retention. Yusof et al. (2016) conducted research into the effect of using singing methods in the teaching and learning process. The researchers had control and treatment groups in which the latter were taught Arabic lexical items by writing words, memorizing and constructing sentences using singing method while the control group were exposed to conventional or traditional methods. The treatment performed better than the control group in memorizing and writing words while there was no significance in building sentences. Grade R teachers are expected to sing with learners as it is fun and helps in emphasising content to the learners.

f) Dramatising

Greenfader and Brouillette (2013) propose that dramatizing as a teaching method helps in improving comprehension and promoting verbal interaction in the classroom. Usually in pre-schools, learners have free or guided play time where they dramatize learnt content by using their imaginations to connect the content with their experiences. When learners dramatize, movement comes naturally to them and thus helps them in their construction of meaning (Piaget, 1962). This is important in a science classroom because they would be given chance to talk about a concept in a relaxed and fun way. They can be given toys and objects that would be used for floating and sinking and then talk about the behaviour of the given objects using water. This method can be demanding as teachers need to prepare beforehand what the learners will do so that they will be able to adapt the “make-believe situation into their own knowledge base” (Mages, 2006).

2.8.1.3. Resources

Resources discussed in this study include physical resources, personal resources and supportive resource.

a) Physical resources

Early Childhood learners are motivated to learn by using concrete materials that can be manipulate (Beni, 2014). This means that in ECD class, an expectation is that learners should be given a large quantity of materials to enhance their learning. Mudulia (2012) suggests that science can be conveyed through “doing,” which requires resources to be available in the classroom. In Kenya, it was found that resources enhance learners’ achievement (Mudulia, 2012), whilst for Arendse (2011) there was a strong correlation between learners’ achievement and resources used. However, science teaching is side-lined in some schools due to contextual factors that include limited resources, funds and teachers’ incompetence.

In order to support science learning, the Lesotho MoET supports the idea of resources by supplying schools with science kits. However, although resources might be available, research indicates that teachers need support to use the provided materials in their science classrooms. A study carried out by Fitzgerald and Schneider (2013) discovered that teachers need support with resources simply because they could either be an enabling or inhibiting factor, with some associated with technology.

Even though resources seem to be essential in each classroom, sophisticated equipment and laboratories do not influence the teaching of science at ECD level, however, due to the advent of progressive teaching it is right if learners are confronted with a situation whereby they will use science equipment. The most helpful aspect in teaching learners some objects is letting them be exposed to them. Muwanga-Zake (2001) explains that when learners are not familiar with the equipment they spend too much time interrogating it rather than learning concepts simplified by equipment. Normally, in the Foundation Phase classroom, learners use household materials that they can also bring from home (Beni, 2014). Use of household materials can easily be related to both the teacher and learners' everyday use and therefore poses less challenging situation when used. Resources that could be used for teaching floating and sinking concepts include toys, spoons, forks, tumblers, earrings, rings made from plastic, metal and wood, washbasin, pencil sharpener, pen, keys, pins, piece of glass, tennis ball, pair of scissors, coins, stones, leaves, balloons, plastic pegs, marble and nails.

b) Supportive resource

Textbooks are reported as substantial and unavoidable tools for facilitating teaching and learning (McDonald & Abd-El-Khalick, 2017). However, there is a scarcity if non-existence of science textbooks at early childhood level in Lesotho. Even in South Africa there is a problem of locating textbooks in teaching of science in the Foundation Phase (Beni, 2014). Preference over textbooks is given to "texts like short fairy tales, animal tales and descriptive texts about children's everyday activities" (Vaik-Luga, 2013 as cited in Müürsepp, 2013:81). Makamure (2016:68) argue that "whilst the textbook is a tool for "learning to teach", teachers do not have to depend on it alone as a teaching resource". Rather, they have to use their curriculum as a guide and their CK to crack the content to be taught.

Although teaching science at the ECD level does not require complex materials, physical space is seen as one aspect necessary for teaching of science (Fitzgerald & Schneider, 2013). However, the aforementioned authors found that teachers are diverse in this view; some teachers believing that science teaching needs its specialised science room while others that they could use readily available space to teach science. Some resources require little space or outdoor space so that learners could be able to “do” science. Activities that involve water and soil may be handled in an outdoor area that is organised for learning.

A sound relationship between the teacher and the learner constitute a better performance and engagement in the classroom (Osher et al., 2020). Such relationship is linked with strong mutual relationship whereby a learner is free to talk to the teacher about anything that concerns learning. Centre for the Developing Child (2016) confirms that brain development is supported by the presence of warm and caring environment that is established in the classroom. Young learners learn best when they can trust and confide in their teachers. This says that the teacher should be warm and open to the learners so that they feel safe and secure. Darling-Hammond et al. (2020: 102) emphasise that “students need a sense of physical and psychological safety for learning to occur, since fear and anxiety undermine cognitive capacity and short circuit the learning process.”

As much as teacher-learner relationship expected at schools so is teacher-learner-parent relationship. Learners are expected to perform well if there is a sound relationship between the teacher, the learner and the parent (Hammond, 2016), more especially if the basis of the relationship is culturally and contextually based. Learners are able to relate well with experiences they had at home and the new knowledge gained at school. If teachers know their learners’ environmental contexts they will treat each child with care and therefore provide them with learning opportunities they deserve (Hammond, 2016). Where there is strong relationship between the school and the parent, learners’ attendance is likely to improve. The rate of dropping out would be minimised as learners would have strong attachment to schools. They will also bring materials asked for by their teachers because of the support they receive from their parents.

Learning time can be extended as to create opportunities for learners who did not catch up during teaching and learning. In preschools the extended learning time can happen at the learning corners during free play or guided play time. Darling-Hammond et al. (2020) indicate that extending time addresses lost time during learning and therefore favours the consistency of cognitive stimulation.

Literature shows that reduced class size enhances learners' performance (Geoff, 2014). Teacher-learner ratio is 1: 45 in Lesotho primary schools (MoET, 2009) while in Grade R is 1:30. Kim (2006) emphasise a threshold of 15 to 18 for young learners. In a continuing debate on class size reduction, Chimbi (2019) states that teachers in his study resorted to paired work and avoided role play as they were afraid that the large classes (against Zimbabwe teacher-learner ratio of 1:35) would not be manageable. However, his findings refuted this. Chan (2016) confirms that there has been debate on the issue of whether class size contribute to learners' performance in Hong Kong schools. Akoto-Baako (2018) argues that reduced class size contributes to high performance of learners because time is saved in managing class for instruction. The small class size is linked to personal attachment of the teacher to the learner as s/he would be able to attend to each learner's needs. Class size can be a factor that could explain teachers' classroom practices, hence it is important to be reviewed in this study.

c) Personal Resources

Whilst physical resources are tools for teaching and learning, outsourcing information from colleagues is another resourceful way of obtaining information. Researchers have reportedly this idea. For instance, Burnette (2017) regards value of teamwork as significant in driving change in an organisation. Geeraerts, Tynjälä, and Heikkinen (2018) found that young colleagues learn practical and contextual information from old colleagues while old colleagues learn innovative teaching strategies and information technology from younger colleagues. Selfless support and open sharing of knowledge amongst colleagues were expressed by teachers as working for effective classroom practice (Sun, Loeb & Grissom, 2017).

Teachers need Continuing Professional Development (CPD) programmes frequently. Mokhele and Jita (2010) regards CPD as a technique that bring about change in a way teachers conduct teaching in their classroom. In agreement with this idea, Demirdöğen et al. (2016) recommend CPD because they believe that it reinforces teachers' pedagogical content knowledge. Many schools sent their teachers for fresher course or workshops in which they are capacitated with subject matter of the content with which they have problems teaching. However, that is guided by the school policy or the choice of the principal, whether he/she sent the teachers to such trainings. By default, each month, preschool teachers in Lesotho go for trainings organised by the MoET under IECCD unit to capacitate teachers with skills to teach learners. The trainings are part of the each year's plan to improve teacher knowledge.

Self-efficacy is an example of personal resources needed by the teacher to help learners execute tasks. It helps teachers to be passionate about what they are teaching, reflecting level of responsibility and engagement that influences learners' performance in the classroom (Gosnell, 2017). Choices the teacher makes relate to learners learning styles and materials to be used. Teachers who possess self-efficacy have perseverance to do well and help to solve learners' problems. These teachers are driven to make an extra effort to help learners or even offer remedial work.

2.8.1.4. Activities

In this study, activities refer to the practices in which teachers and learners execute instructional task for learning. In this manner, classroom activities are designed by the teacher to meet the planned objectives derived from the content in the curriculum document used in a school (Gagne et al., 2005). Again, Gagne et al. (2005) emphasise that classroom activities rely solely on objectives and the selection is guided by, among other things, the level of the learners, their characteristics and the school context. Accordingly, classroom activities are guided by the planned objectives. Green (2010:213) wrote:

> I need to more closely align my course objectives, classroom activities, and assessments with one another. This does not mean that I should teach to the assessment. Rather, it means that I need to provide appropriate experiences in my course goals and instructional activities that make use of the same cognitive and knowledge dimensions as the assessments I use.

A similar argument is made by Biggs (2003), when citing that systematic and constructive alignment is needed in the classroom so that the learners will benefit from what was initially intended. Firstly, Biggs suggests that the setup of the learning environment should support the learning activities after careful consideration of the lesson objectives. Then the teaching method used and the assessment tasks employed should align with the assumed learning outcome, thus preventing learners from escaping learning what was intended to be learned and aligning teaching for constructing learning.

Since learning in science classroom involves inquiry-based learning, Zuckerman et al. (1998) identified three dynamics that are vital in teaching to resolve teachers' struggle with what teaching and learning in science classroom looks like. The first factor is based on the arousal of learners' existing knowledge that is within their zone of proximal development, thereby narrating imaginary and breath-taking scenarios that would lead learners to acquisition of new knowledge. Secondly, opportunities for learning need to be provided by the teacher so that learners could cooperate with others and learn from one another. The last factor is based on the scaffolded instruction in which the teacher would help learners to go through the process of acquiring new information until the learners could take control of their learning.

The process of science that includes observing, recording and communicating would be emphasised when performing scientific activities (Campbell & Chealuck, 2015). Procedural knowledge of how to complete task would be acquired as well as conceptual knowledge when concepts are emphasised in conclusions. Darling-Hammond et al. (2020:101) emphasise that “authentic, engaging tasks with real-world connections motivate student effort and engagement, which is supported through teacher scaffolding and a wide range of tools that allow for personalised learning and student agency”. Therefore Individual lessons usually emphasize only one or two skills to help children feel comfortable with new concepts. For instance, students will predict which objects sink or float in water. The activities that they will be doing would include observing, describing, and keeping records about what happens when objects are placed in water. Students will make and test predictions about sinking and floating. They will classify objects according to physical properties. Students will develop process skills in observing, questioning, predicting, interpreting, and communicating. Different activities which are fun could be done with a small group of learners, pairs or the whole class indoors or outdoors. Activities could be achieved if learners could successfully meet the desired outcome (Gagne et al., 2005). It is yet to be found if teachers in this study are able to align activities with objectives, assessments and conclusions that reflect teachers’ understanding of the concept.

In early years of teaching, novice teachers may struggle to construct their lesson activities in such a way that it support learners’ activities. Pennings and Hollenstein (2020:383) emphasise that:

> “when lessons keep being poorly organized, this might evoke distraction and chatting among students, which in turn may lead to dissatisfied teacher behaviour; the more often lessons are poorly organized, the more easily students may become distracted, the more easily aversive teacher behaviour may be triggered (i.e., teacher-student attractor), and the less likely friendly teacher or student behaviour is triggered (i.e., teacher-student repellor)”.

Consequently, if classes are confronted with novice teachers, their classroom interaction would be poor and lead to negative teacher-learner relationship. Thus create the problem of classroom management. However, Ghanaguru et al. (2017) indicate that a well-structured activities in planned lesson has positive effects on learners' attainment and enhance a well-managed classroom environment. They also suggest that learners will achieve more if teachers are more involved. This study is trying to find what activities teachers do in the classroom to enhance their procedural knowledge of science skills and conceptual knowledge of science concepts.

2.8.1.5. Assessment and Conclusion

Assessment and conclusion should also align with lesson objectives (Biggs, 2003; Green, 2010). Whether the process of teaching and learning was successful or not, all depend on the procedures followed during the assessment and conclusion. In this study, assessment refers to the process of inquiring from the learners whether what was planned by the teacher starting from the objective to the performance of the activities has been retained by the learners (Norton, 2009). Conclusion refers to the final message that is communicated based on the content. In this study, I wish to establish how preschool teachers' science content knowledge influence what they do in the classroom.

The South African Department of Education (2011) regard assessment as an integral part of learning and forms part of components of lesson plan. Whilst DeLuca and Hughes (2014:455) agree that teachers share "mutual approach to assessment in the early years". Commonly, learners are assessed knowledge and skill through various strategies such as observations and performance based activities. It is carried out to ensure that learners are developing in their learning.

In light of finding out whether learning has occurred and how that happened, teachers' lesson plans under assessment component as well as how they concluded would tell if teachers have sufficient CK and if what they tell learners adhere to good assessment and conclusion procedures. If the content delivery was well received by all the learners in the classroom, teachers' fair assessment procedures would accommodate all the learners, regardless of their learning situation and abilities.

There are different purposes of assessment, for example, promoting learners' performance thereby providing feedback and determining readiness to move to the next grade level (Norton, 2009). There is formative and summative assessment. Formative assessment is carried out during teaching and learning with the purpose of improving learners' performance while summative is carried out mostly at the end of the learning level to determine progression (Looney, 2010).

Although learners are assessed in early childhood education, there is a "no fail" concept as learners move to the next class, whether developmentally ready or not (MoET, 2011). For the Grade R teachers, there could be no intention to work hard and see that learners' progress to the next level being ready. They might not care about employing good assessment and procedures for they know that learners would go to Grade 1 whether ready or not.

Assessment activity that could be undertaken after teaching the concept of "floating and sinking" would be to ask learners to "name" objects that float or sink in water if the objective asked them to "name floating and sinking objects". That has to speak to the content of the valid assessment that measures what was intended to be measured. A teacher could design his or her own assessment worksheets that correspond to what was learned. The conclusion would be based on the planned objective as a closure of the lesson.

2.9. Knowledge gaps in this study

Although a burgeoning interest in Shulman's Teacher Knowledge Framework and Ball's Content Knowledge for Teaching was noted, at the level of early childhood learning, a study in Lesotho conducted by Setoromo et al. (2020) focused on Lesotho Grade R teachers' mathematical knowledge for teaching numeracy, guided by the work of Shulman and Ball. I found it necessary to investigate teachers CK in science, which is rarely undertaken in early childhood. I also noted a gap in research in mapping out science teachers' CK on selected concepts (Floating and sinking) with their classroom practices. In studies about science teacher content knowledge, most research has been on how teachers' subject matter influenced their learners' performance (Sadler, 2013; Diamond et al*.,* 2013; Gess-Newsome, 2015; Ekici, 2016). Little was said about how their CK influenced their classroom practices or about how Grade R teachers' science content knowledge influenced their classroom practices. Kallery and Psillos (2001) investigated how pre-school teachers' science content knowledge helped them answer learners' everyday science question in the classroom. This study maps teachers' science content knowledge with classroom practices. Studies around the concept of floating and sinking had been done. Most of the studies measured how learners conceptualise floating and sinking (Andersson & Gullberg, 2014; Dentici et al., 1984; Hadzigeorgiou, 2015; Havu-Nuutinen, 2005; Hsin & Wu, 2011).

2.10. Summary

The purpose of this chapter was to explore related literature guided by the research questions. The literature review began with exploration of Shulman's Teacher Knowledge Framework and Content Knowledge for Teaching (CTK) framework for they form the construction of this study. Related literature that specifically talks to the research questions were reviewed, helping me gain knowledge and ideas of what has been researched in relation to my research topic, which is: "The influence of Lesotho Grade R teachers' science content knowledge on their classroom practices". This allowed me to discover the researched studies and identify the gap that this study intends to bridge.

This study anticipates making a contribution to the knowledge as it discovered that little has been done in mapping pre-school teachers' science content knowledge with their classroom practices. A feel of how teachers CK can be established and how an effective science classroom should look are reviewed. Science teacher content knowledge and how they teach selected concepts (floating and sinking) were also reviewed in this chapter.

The next chapter gives details of the research design and methodology used in this study. This includes explanation of pragmatic paradigm and sequential explanatory mixed methods design that were followed. Questionnaire, interview, observations and lesson plans are clearly explained as to how they were used as data generation instruments. Other aspects of research such as sampling, techniques of collecting data, as well as purposive sampling, ethical issues and limitation of the study are explained.

Chapter 3.

RESEARCH METHODOLOGY AND DESIGN

3.1. Introduction

Chapter two examined the theoretical framework that guides the study and related literature that talks to the research questions. This chapter presents the research methodology, design and procedures employed. In order to explore fully the influence of Grade R teachers' science content knowledge on their classroom practices, a mixed-method research approach on explanatory sequential design was followed for data collection, analysis and interpretations.

Included in this chapter are research questions and how they emanate from the existing theory in the context in which they were applied. The position of the researcher is detailed and adherence to ethical considerations elaborated. A pragmatic paradigm is explained as to how its choice was deemed important in the research. Selection of sample, ethical issues and limitations of the study are explained.

3.2. Purpose of the Study

The educational significance of this study is to advance the literature in the field of science education based on the topic: "The influence of Lesotho Grade R teachers' science content knowledge on their classroom practices." The findings should contribute to the existing body of knowledge and literature related to early childhood setting, assisting researchers with practices, beliefs and attitudes of preschool teachers when teaching science. It should also inform institutions training them on science concepts and the way they could improve their practice. The findings are also intended to inform curriculum designers in strengthening areas that contribute to teaching of science. Necessary interventions and content evaluation are considered.

3.3. Research questions

When embarking on the research questions, Cohen et al. (2011) suggest that it is useful for the researcher to keep in mind the influence and role of the research questions. Yin (2014) adds that research questions elicit information relevant to research methods to be followed with the essence of each reflected in the methods. The main research question, followed by four secondary research questions that guided the conception of this research, are repeated here:

> **What is the influence of the science content knowledge of Grade R teachers on their classroom practice?**

The aforementioned question directs the feasibility and affordance of the following secondary questions:

1. What is the science content knowledge of Grade R teachers' in Lesotho on selected science concepts?
2. How do Grade R teachers teach the selected science concepts to their learners?
3. How does teachers' content knowledge of science shape their classroom practice?
4. How can the Grade R teachers' content knowledge and practices on science be understood and/or explained?

The fundamental nature of the first secondary research question was to explore the knowledge base of Grade R teachers' in Lesotho on selected science concepts in pre-school. Water is one of the concepts mostly taught in early childhood and often the concepts are called 'themes' (Ministry of Education and Training, 2011), divided into sub-themes. In this study the sub-theme *floating* and *sinking*, categorised under the theme '*water'* is used in measuring Grade R teachers' science content knowledge. Following the conception of Shulman's (1986) knowledge base, I was able to interact with Ball et al.'s (2008) content knowledge component guided by common content knowledge (CCK), specialised content knowledge (SCK) and horizon content knowledge (HCK) of teachers in science. Teachers' beliefs, content knowledge (CK) and problem-solving strategies were explored, including how they explained the sub-theme, demonstrated what had to be undertaken and engaged learners in understanding the themes (Etkina, 2010). Data used to generate teachers' responses was obtained through use of a questionnaire survey, which was triangulated with interviews, classroom observations and teachers' lesson plan, in which the concepts of floating and sinking were planned.

The second research question "How do Grade R teachers teach the selected science concepts to their learners?" sought to find different behaviours of teachers as they performed their knowledge and skills they were supposed to display when teaching science in Grade R. In this regard, the framework that guided this question emanated from theoretical frameworks presented in chapter 2. The theories were used in order to find out how the Grade R teachers taught the selected topics of floating and sinking. Examples of behaviours observed and the use of appropriate science terms, methods, conceptions and misconceptions the teachers had on the topic were attended to, because in studies carried out previously it was found that science teachers had various misconceptions and sometimes little knowledge of the concepts they presented.

The teachers' levels of using appropriate teaching instructional strategies and consideration of learners' learning styles were observed. Learners' responses were observed with the intention of seeing whether teachers considered learners' previous knowledge before they could pursue new knowledge responding to their questions. Data for this second question was largely collected through the use of classroom observations, pre-observation and the post-observation interviews to obtain rich data from the observed participants, their basis of the observed reactions and the reasons behind their employment of strategies.

The third research question “How does teacher’s content knowledge of science shape their classroom practice?” was necessary as it connects how teachers think about science and the actions that lead to teaching it. This question helped in determining teachers’ knowledge of science content and connecting that to the way they taught their learners. Data was generated through a high level of synthesis based on teachers’ interviews, classroom observation and lesson plans. What and how they taught floating and sinking to their learners helped me to interpret their CK base and how it influenced their practice.

The fourth research question “How can the Grade R teachers’ content knowledge and practices on science be understood and/or explained?” required conjecture on Grade R teachers’ practices by enlightening insights that initiated teachers use of and performance in the practices of teaching science during their classroom interactions. This question initiated synthesis and analysis of the research with the hope of closing the identified gap in literature. The work of Shulman (1986, 1987) and Ball et al. (2008) helped me to theorise relevant information that clearly indicates the gap that led to the engagement of this study. The answers to this fourth question were provided by generation of data from all tools indicated. Inductive thinking and reasoning afforded me the opportunity to bring together pieces of information so that the new body of knowledge could emerge.

3.4. Research Methodology

Research methodology “is the general approach the researcher takes in carrying out the research project; to some extent, this approach dictates the particular tools the researcher selects” (Leedy & Ormrod, 2013:12). In this research, the approach involved both quantitative and qualitative (mixed method) approaches. It involved the choice of pragmatic paradigm, participants and the sampling plan, the research design to be followed, data generation procedures, and apparatus and measuring instruments used, so that the relationship between the questions and the data emerges clearly.

3.5. Research Paradigm

Once researchers want to embark on the research study they need to understand their philosophical underpinnings that inform how they will uncover knowledge (epistemology) and how to uncover that knowledge (methodological approach). These logically related assumptions or propositions that guide how one embarks on research is a ‘paradigm’ (Mack 2010), defined figuratively as a toolbox of theories, beliefs and practices (Tracy, 2013). Early educational research was guided by positivist, succeeded by post-positivist, interpretivist, transformative and pragmatist paradigms (Creswell & Plano Clark, 2011; Mertens, 2010; Teddlie & Tashakkori, 2009). The following sections explains pragmatic paradigm, as the one selected for this study.

3.5.1. Pragmatic Paradigm

I used a pragmatist paradigm as a lens through which to gain perspective on the study. Pragmatism rejects the idea that the world is as an absolute unity, rather it emphasises the practical application of thoughts. Similarly, researchers employing mixed methods collect and analyse data rather than opting for a single method (Creswell, 2014). Unlike positivist and interpretivist research philosophies, pragmatism can be used to integrate more than one research approach and strategy within the same study. Hence, advocates of mixed methods research support the pragmatist paradigm (Cohen et al., 2011).

The pragmatist paradigm recognises that researchers have freedom to use procedures and techniques aligned with either quantitative or qualitative research. This is favoured because the limitations of one would complement the other (Creswell, 2014). It explores understanding Grade R educators’ practices during the teaching of science and how their content knowledge influences classroom practices. According to Cohen et al. (2011), social factors such as contexts and cultures contribute to construction of these realities, therefore participants’ contexts allowed me to synthesize how their science knowledge influenced their classroom practices.

The rational for engaging a pragmatist paradigm is influenced by a consideration that teachers are products of the phenomenon in which they are working, and initiators of what they want to do (Cohen et al., 2011). This allowed me to interpret teachers' beliefs, attitudes and behaviours because I interacted closely with them to gain insight and form a clear understanding as to how they teach science.

A qualitative approach favours understanding of human experiences (Creswell, 2014), which is what I considered by being in the classroom in which the pressures of teaching content to the learners are felt and observed during teaching and learning discourse. I was in a position to explore the realities attributed to Grade R teachers' science content knowledge and classroom practices. Approaching the study in this manner adds a pragmatic perspective as such studies attempt to focus on the outcomes of research, actions, situations and consequences of the inquiry rather than antecedent conditions (Creswell, 2014). Pragmatics are aligned with axiology, which takes the stance that the value of evaluations is not based on whether they discover the truth but on a demonstration of the results with respect to the problem being studied (Mertens & Wilson, 2012).

The point of quantitative and qualitative study being pragmatic is strengthened by Creswell's (2014) statement that the findings of a study are developed by the researcher in making sensible interpretations of analysed data, thereby deriving themes or categories and drawing conclusions to the findings. Therefore, I focused on what knowledge Grade R teachers had that led them to the practices they engaged in the classrooms in order to understand how they constructed a social world by sharing meanings, and their interaction with learners when teaching science. This gave me an opportunity to share my understanding and/or explanation of how Grade R teachers' content knowledge of science influence classroom practices.

3.5.2. Research approach: mixed methods approach

In this study, the researcher felt the need to engage mixed methods approach due to the nature of the research question because methods of data generation involved objective and subjective views of the teachers. A mixed methods approach, explained as "an approach to inquiry that combines or integrates both qualitative and quantitative forms of research" (Creswell & Creswell 2018:41). It caters for both quantitative and qualitative research activities because of the nature of its design. In quantitative approach, researchers engage the means in which objective theories are tested by exploring the association between variables which can be measured using instruments that would allow data to be analysed statistically (Creswell & Creswell, 2018). It is affirmed by Creswell (2014) that the quantitative domain is based on data influenced by statistical inferences. This supports the view of Plano Clark and Creswell (2014), who asserted that researchers who follow a quantitative approach engage quality measures usually displayed in terms of numbers. Similarly, Rubin and Babbie (2010) define quantitative research as empirical research in which the data is presented in a numerical format. I delved into questions to guide an investigation into Grade R teachers' science content knowledge. The generated data allowed me to quantify teachers' knowledge using the questionnaire, to be analysed and presented in the next chapter.

A qualitative approach, meanwhile, aims at gaining a deep understanding of a human group in its social setting. It is an inquiry process of understanding how participants derive meaning from their surroundings, and how that meaning influences their behaviour in a natural setting (Rubin & Babbie, 2010). My intention was to obtain first-hand information by observing and interviewing participants on how their knowledge influenced their classroom practices. Their actions, attitudes, behaviours and intentions allowed me to rate their level of knowledge on science concepts. This approach recognises an active relationship between the researcher and the participants of the research and how those participants interact with their experiences in real-life contexts (Rubin & Babbie, 2010).

Creswell and Creswell (2018:41) explain qualitative research as “a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem.” They further indicate that the process involved in a qualitative approach includes focusing on questions that emerge, data generation procedures in the natural setting of the participants, and processing it in such a way that it will generate themes and allow for interpretations of generated data.

Both approaches allowed me to engage objective and subject views of the participants about the research problem. An initial phase of quantitative data generation and analysis was followed by a phase of qualitative data generation and analysis. I used a questionnaire to generate data that informed classroom observation, and face-face interviews. The findings of these two phases were integrated during the interpretative phase, as depicted in Figure 1.2 (Chapter 1), which clarifies their sequential flow. Creswell (2014) indicates that an explanatory sequential strategy is easy to implement, and straightforward to describe and to report. Ultimately, the successful implementation of a quantitative research approach allowed me to expand on the qualitative findings and to develop observation and an interview schedule.

3.5.3. Research Design: Explanatory sequential

Research designs “are types of inquiry within qualitative, quantitative, and mixed methods approaches that provide specific direction for procedures in a research study” (Creswell & Creswell, 2018:335). This means that researchers plan how they will embark on procedures that would help in establishing how variables relate in a study. Mixed methods approach has various designs, namely: “Triangular or converging parallel design, explanatory sequential design, exploratory sequential design and integrated or nested design” (Piccioli, 2019: 430-432). I followed the explanatory sequential design because in this design, “the researcher first conducts quantitative research, analyzes the results and then builds on the results to explain them in more detail with qualitative research” (Creswell & Creswell 2018:52).

The explanatory sequential design in this study focused on interpreting and explaining relationships between the variables, which are teachers' science content knowledge and how it relates to their classroom practices. The approach took the form of survey design, using questionnaire, semi-structured interviews, classroom observations and lesson plan analysis, termed *explanatory mixed method design* (Creswell, 2014). This means that I collected data in two phases, the first of which helped clarify the phenomenon for the second. It afforded me use of the survey to obtain a broad spectrum of the problem then explain the picture in a qualitative phase.

Survey research in the form of using a questionnaire was employed in the first phase. It frequently informs the conditions in which data is found, gathering it numerically with the aim of testing hypotheses or answering questions guiding the study (Airasian, 2014). I was guided by the research questions to gather information, mainly focused on what science content knowledge Grade R teachers had specifically on the floating and sinking concepts, and how they taught them. I wished to obtain profound information on Grade R teachers' science content knowledge and how it influenced their classroom practices. I adopted this design because, while conducting the literature review I realised that science teacher content knowledge could be reviewed on many different educational levels, with less focus on the foundational phase. The little literature that existed led me to survey the context of the Lesotho Grade R teachers' science content knowledge as a factor and how it influenced their classroom practices. Again, the design suited the study because questionnaires covered a large sample of the population. The rationale for choosing that sample is explained under the 'participants' section.

The study design allowed me to invite four participants to be interviewed, observed and have their lesson plans analysed. I adopted this design because I wished to explore teachers' practices while teaching science in Grade R. I visited teachers at their respective schools to interview and observe them in classes. Their lesson plans were analysed at my own time at home.

3.5.4. Participants

The context of this study was in the district of Maseru, Lesotho, a mountainous country landlocked by the Republic of South Africa. Maseru is one of ten districts, classified as urban, semi-urban and a foothills area. Preschools operate in these ten districts, catering for zero to five-year olds. They are home-based, centre-based and reception classes, attached to primary schools (MoET, 2011). The reception class is also known as Grade R, a name used mostly in this study. The Lesotho Ministry of Education and Training's Education Statistics Report for 2014 records that the total number of Grade R classes in the country was 340, with a total enrolment of 6,178 learners and total of 3,700 Early childhood development (ECD) teachers (MoET, 2014). The study was conducted in three regions of Maseru district, namely, urban, semi-urban and foothills. Survey instruments were utilised on teachers with interviews, observations and document analysis from the four Grade R teachers in the aforementioned context.

Elfil and Negida (2017:1) define the population "as a group of people who share a common character or a condition." These should be the holders of information the researcher is looking for. In this study the focus of the population was on teachers working with small children, from whom a sample was derived, that is, including a part of this population known as the "sample population" (Elfil & Negida, 2017:1).

When dealing with sequential mixed methods sampling, Cohen et al. (2018) suggest that one sample of participants should precede another sample due to the research results which could be homogeneous or highly varied. Grade R teachers provided the data needed. In order for the researcher to obtain an initial sample with suitable characteristics, the criteria were that participants be Grade R teachers who obtained a Certificate in Early Childhood Education and be in different demographic regions of Maseru district in Lesotho. To avoid unbiased representation, I considered Ahmad and Halim's (2017) advice that one has to choose the sample size that is appropriate to the population such that it will be easy to measure and record. Therefore, I used the statistical software developed by Creative Research Systems (https://www.surveysystem.com/sscalc.htm), with a confidence level of 95% and entered confidence interval of 5. My population was 135 of Grade R teachers who met the criteria detailed above. When calculating, I obtained the result of 100 teachers. I used an opportunistic sampling which is classified under purposive sampling. It is one of the unique strategies for generating data in which further individuals as the case of this study would be contacted as the research develops (Cohen et al., 2018). Grade R teachers usually came for their monthly meetings at the district office, so I took the opportunity to talk to their National Teacher Trainer to present my study. I was given a slot of ten minutes to talk to the teachers, with one hundred asking to participate in this study voluntarily. I made arrangements with them to visit their schools so that they could respond to the questionnaire forms.

In the second phase of this study I used convenience sampling, discussed by Cohen et al. (2018:218) as "accidental or opportunity sampling, [which] involves choosing the nearest individuals to serve as respondents and continuing that process until the required sample size has been obtained of those who happen to be available and accessible at the time". It allowed me to choose the nearest individuals to serve as respondents (Cohen et al., 2011), keeping in mind that I had to sample from urban, semi-urban and a foothills area. Four teachers from the sample were observed during classroom discourse and interviewed. I kept in mind the three geographical areas of Maseru, which are urban, semi-urban and foothills. This was influenced by Spaull's (2013) finding that teachers located in urban areas had more content than their counterparts in the townships. The aim was to triangulate information found in the first phase and to capture teachers' own knowledge, belief and insights regarding science knowledge and their application.

The selection of a few participants is considered by Cohen et al. (2011:145), who indicate that "sample size might be constrained by factors such as money, resources and time, as a result the sample size will be small." My choice made it easier to collect data because transport costs and the time factor were minimized. I chose only four participants so that I could generate rich data to establish a profound understanding of the teachers' backgrounds regarding their practices in the teaching of science in Grade R classes. This was done by engaging various data generating techniques such as interviews, observations and document analysis.

3.5.5. Data generation instruments

The choice of data generation instruments and their corresponding operation manuals is a key step of this study design. It was carried out with well-established rules, as in the case of designing interviews and questionnaires, highlighted by Plano Clark and Creswell (2014) as testing instruments for any research study. They are used in various situations that guided previous studies so that speculated risk factors and their outcomes would be avoided. If instruments could be used and suspected factors not avoided the study would be null and void. Therefore, choice of data generation instruments is of utmost importance. In this study, a questionnaire, semi-structured interviews, classroom observations and document analysis were administered and chosen as instruments.

3.5.5.1. Questionnaire

I used a questionnaire as the first document to collect data in the first phase of this research. According to Phellas et al. (2011), a questionnaire is inexpensive to administer and covers a wide range of geographical situation. Two main types of questionnaire are the open and closed, the latter, according to Creswell and Creswell (2018), being used to restrict the answer so that respondents are able to answer the questions quickly. I decided to use a closed questionnaire as it afforded me a chance to analyse a large amount of data relatively quickly. That I did with the caution that mixed methods research can be lengthy if not carefully deliberated as it is two studies within one (Piccioli, 2019). I designed a questionnaire protocol that would help me analyse teachers' content knowledge, thereby using the results to plan for the qualitative phase. I adopted construction of the questionnaire from Baeten et al. (2013), TIMSS Questionnaire (2015) and Horizon Research, INC questionnaire (2012).

The questionnaire forms, included in **Appendix A**, have various content knowledge domains. For instance, Section A covers teachers' biographical details; Section B: details on teachers' perceived common content knowledge of science concepts; Section C: Teachers' perceived specialised content knowledge on floating and sinking; Section D: Teachers' perceived horizon content knowledge; Section E: Teacher-oriented classroom practices; and Section F: Learner-oriented classroom practices. Use of a questionnaire allowed for a structured approach but restricted respondents to choose from a Likert scale. Five alternatives were rated from *strongly agree, agree, neutral, disagree* and *strongly disagree*. The most positive weight was five points while the least positive weight one point. This helped the researcher to enter assigned scores into Statistical Analysis Software (SAS).

Before administering the questionnaire forms I requested a meeting with the Maseru district national teacher trainer to talk to Grade R teachers when they had their monthly meeting so as to talk to them about my research. Upon their agreeing to be part of the study and fill in the consent forms I distributed the questionnaire. The importance of hand-delivered questionnaires lies in the information being completed in time (Cohen et al., 2018). In this way, much time was saved and the response rate was raised because of the personal contact, and my merely distributing the questionnaire and explaining where clarification was required.

The questionnaire form was constructed from Ball et al.'s (2008) CK and Shulman's (1986, 1987) components model, as explained in Chapter 2. The model afforded me the opportunity to understand influence of Lesotho Grade R teachers' science content knowledge on their classroom practices. It is indicated in Shulman's 1986 conceived theory that teacher content knowledge could be tested and evaluated. Also, I formulated some questions based on various domains of CK and asked authorities in research to verify them to ensure issues of validity and reliability. Findings revealed through use of questionnaire informed the second phase.

3.5.5.2. Interviews

An interview is a social encounter between interviewer and interviewee(s), with the intention of exchanging views that would produce new knowledge (Cohen et al., 2018). There are different types of interviews, ranging from structured, unstructured and semi-structured. Alvesson (2010) suggests that the structured interview is useful when the researcher is aware of what s/he does not know and therefore is in a position to frame questions that will supply the knowledge required, whereas the unstructured interview is useful when the researcher is not aware of what s/he does not know, and therefore relies on the respondents to tell her or him. This study is on the continuum of the two, hence I settled on semi-structured interview. My interview schedule was guided by the response from quantitative study, allowing me to probe participants when I needed clarification so that I could obtain rich responses. Conducting semi-structured interviews with such intention concurs with Alvesson's (2010) clarification that an interview schedule is planned in advance so that the researcher can ask predetermined questions aided by unplanned ones. A semi-structured interview therefore combines both the structured and unstructured styles.

Semi-structured interviews were carried out in collection of data, the rationale being to find some answers from teachers that related to the research questions and information gathered from the literature study. I followed two interview schedules that were prepared beforehand, namely, pre-observation interview, used before observing teachers (**Appendix B**), and post-observation interview, used after observing teachers. I conducted pre-observation interviews with the purpose of identifying relationships between what they knew before teaching and what they said they knew would be reflected in their practice. The post-observation interviews interrogated what guided their teaching of the concepts of floating and sinking, how they felt about their lessons, and what they suggested could be done to help them to improve their practice if needed. The post-observation interviews were also guided by what occurred in the classroom that needed the researcher to understand, for example, I had to ask one participant to explain why a plastic shaped kite sank in water. These interviews were conducted between mid-February 2019 and late-May 2019, using a design that gave me an opportunity to determine the questions, identify emerging lines of inquiry and probe the participant to elaborate on their responses (Cohen et al., 2018). This is also recommended by Cohen et al. (2011:411), such that:

> By providing access to what is inside a person's head, an interview makes it possible to measure what a person knows (knowledge or information), and what a person likes or dislikes (values and preferences), and what a person thinks (attitudes and beliefs).

The interviews were face-to face and conducted in the participants' respective classes on agreed dates before the commencement of the classroom observations. I prepared the interview schedule before I could commence with interviews, with insight for doing so based on Leedy and Ormrod's (2013:154) advice that, "Novice researchers often have greater success when they prepare a few questions in advance and make sure that all of the questions are addressed at some point during the interview." Therefore, the two types of interview (pre-observation and post-observation) were carried out based on the advice of Leedy and Ormrod (2013). The questions included main questions, follow ups and probing questions as indicated in **Appendix B.** The main questions were intended for the teachers to illustrate their science content knowledge. When the need arose it was followed up by a probing question that needed clarity on some information. Some probing questions which were deemed critical were written into the schedule so that I could refer to them during the interview. They offered me an opportunity to determine teachers' views on conceptual understanding of floating and sinking, their use of teacher and/or learner-centred pedagogy, as well as the teaching methods they employed in their lessons.

Before the actual interview date I had visited the participants' school to give them consent forms to sign, which they did (see **Appendix H)**. None of the four teachers who participated in the interview was forced in. The participation was free and voluntary. I introduced myself and explained the purpose of the interview and how it would be conducted, for instance, explaining to the participants that I would write some notes if needed, and therefore they should not be distracted by it. Again, I asked permission to audio record our interviews so that I could transcribe them later. I assured them of anonymity as their names would not be used and the recordings would be kept safely and destroyed after completion of the study. This was in line with Creswell and Creswell's (2018:183) assertion that "interviewee's informed consent to recording should be gained and anonymity must again be assured." I used pseudonyms to protect recognition of their actual names and informed each that they were free to withdraw from the research at any time they wished. The information that teachers gave in their schools were not shared with anybody as a way of ensuring confidentiality.

During the interviews, I audio-recorded what the teachers said concerning their science content knowledge on floating and sinking and how they taught those selected concepts to their learners. I observed each teacher's body language and gestures and used handwritten notes to support the recording. Use of a voice recorder permits a larger amount of data to be collected than using handwritten notes only (Cohen et al., 2018).

3.5.5.3. Observations

I employed observation as one of data gathering tools as a way of gathering evidence on how teachers' classroom practices were influenced by their content knowledge. Observation is a crucial data-generating tool which provides the researcher with first-hand information needed to investigate the behaviour of groups or an individual in a setting (Cohen et al., 2018). It is used in many disciplines, such as psychology and education, to be gathered directly, unlike in questionnaires, to minimise distortion of meaning (Creswell, 2014). Consequently, observation afforded me the opportunity to interact with participants in their natural setting, demonstrating their knowledge and how the knowledge they had would influence their practice.

I developed the observation tool which was semi-structured, that is, my observational behaviours were well scheduled in advance. Cohen et al. (2018:543) indicate that “semi-structured observation will have an agenda of issues but will gather data to illuminate these issues in a far less predetermined or systematic manner.” In line with the concepts “floating and sinking,” the tool focused on how the teacher clearly states the objective, captures learners’ attention and connects prior knowledge with new knowledge in an introduction, and uses appropriate teaching and learning materials. Appropriate teaching methods and strategies whereby the teacher could explain the terms or concepts to the learners, engage them and corrects their mistakes, looked at. In the schedule was also an activity part that sought to find out whether teachers’ activities were teacher-oriented or learner-oriented. Teachers’ content, assessment and conclusions were observed as to whether they were accurate and addressed planned objectives.

Prior to my observation schedules I tested my observation tool on two teachers near my workplace. The teachers did not form part of the main participants, but my intention was to test whether I would be able to gather the required information in relation to my research question. I adjusted some points which needed to be improved, and classified teachers’ practices into teacher-oriented and learner-oriented practices. My role during classroom observation was one of non-participant, seated quietly in a corner from where I was able to see what was happening. The data generated was audio-recorded and field notes written as suggested by (Cohen et al., 2011). This gave me the opportunity to understand teachers’ practices better (See observation schedule in **Appendix C)**.

Besides signing the consent form, I also explained to the participants that they would be observed and their lessons audio recorded and activities captured if the need arose, for the purpose of gathering evidence. I assured them of the confidentiality of their lessons and that no information on them would be shared. Cohen et al. (2018:558) warn that:

> to undertake observation, as with many other forms of data collection, requires the informed consent of participants, the right not to be observed, permission from the school and the parents, and perhaps clearance concerning the researcher's reliability and safety to work with young people in schools.

I sought permission from the principal to access schools and work with participants in their respective classes (see **Appendix G**).

My plan was to observe each teacher teaching the concepts of floating and sinking, however, due to different context of the schools and how they taught, I managed to observe a minimum of two lessons and a maximum of five. I observed 15 out of 20 lessons I had anticipated, but in the time, I was able to understand and explain Grade R teachers' science content knowledge and how it influenced their practices.

3.5.5.4. Document analysis

The procedure referred to as document analysis involved perusing documented data such as files, diaries, field notes and books (Mayring, 2014). I analysed teachers' lesson plans after interviewing and observing them. I look at their lessons before teaching so that I could follow what they were teaching and record it on my observation template. After teaching I asked participants to allow me to photocopy their lesson plans in which the concepts of floating and sinking were included. Creswell and Creswell (2018:264) deliberate on the advantages of document analysis as an "enabler for obtaining the language and words of participants, and an unobtrusive source of information," which can be regarded as reliable and authentic because it represent participants written information. The authors emphasise that documents are written evidence that can be visited and revisited because they are physical available.

Analysing participants' lesson plans was necessary as it added to the credibility of my study, determining whether the teachers were able to align age-appropriate objectives of the concepts to the activities, assessment and conclusion, as well as the teaching and learning materials. I wished to see whether what the teachers said they would do was evident in their day-to-day documentation. The analysis was guided by the designed research questions and research objectives, for example, I could compare the teachers' ability to use age-appropriate scientific skills and explanations to the literature in chapter 2.

Teachers' responses could be confirmed by observing the actual lessons. Kawulich (2005) asserts that teacher knowledge is generated through observation, hence I observed and analysed the four participants' lesson plans. Analysing documents confirmed the science teacher content knowledge in response to the survey and interview responses they gave (see **Appendix D** for lesson analysis plan). Below is the summary of data generation procedure.

Table 3.1: Summary of data generation procedure

Sub-research question	Data generation strategy	Data Source
1. What is the science content knowledge of Grade R teachers' in Lesotho on selected science concepts?	- Questionnaire - Interviews - Lesson observations Document analysis	- Grade R teachers - Lesson plans focusing on the concepts "float and sink" - Science lessons focusing on "float and sink" concepts
2. How do Grade R teachers teach the selected science concepts to their learners?	- Interviews - Lesson observations Document analysis	- Grade R teachers - Lesson plans focusing on the concepts "float and sink" - Science lessons focusing on "float and sink" concepts
3. How does teachers' content knowledge of science shape their classroom practice, if?	Questionnaire - Interviews - Lesson observations Document analysis	- Grade R teachers - Lesson plans focusing on the concepts "float and sink" - Science lessons focusing on "float and sink" concepts
4. How can the Grade R teachers' content knowledge and practices on science be understood and/or explained?	- Questionnaire - Interviews - Lesson observations - Document analysis	- Grade R teachers - Lesson plans focusing on the concepts "float and sink" - Science lessons focusing on "float and sink" concepts

3.5.6. Data analysis procedures

Data analysis is defined by Johnson and Christensen (2014) as a process of searching for patterns in the data, constructing themes and conjectures that are derived from interviews, observations and documents. They add that it concerns accumulating information from a sampled population so that it can be sorted, clarified, questioned and synthesized. The analysis of data was designed to comply with the stated purpose of this investigation and answer each research question. I used parallel analysis in which both quantitative and qualitative analysis were conducted independently (Teddlie & Tashakkori, 2009), without mutual influence. On the completion of qualitative data analysis, integration of results from both phases was compared and consolidated.

3.5.6.1. Quantitative data analysis

My data tools were framed within the theoretical framework of Shulman's Teacher Knowledge Framework and Content Knowledge for Teaching (CTK) that guided the study. The survey instrument comprised 74 questions or items, divided between the demographic variables, three CK domains and two teaching approaches. The first domain was on "perceived common content knowledge," a component based on how teachers perceived their common content knowledge with regard to their knowledge exposure, their scientific explanations and conceptual understanding of floating and sinking. The second component was "perceived specialised content knowledge," related to how teachers understood why objects float and sink in water as well as the scientific process involved. The third concept was "perceived horizon content knowledge," which focused on teachers' knowledge of curriculum view with the focus of knowing what could be taught in higher grades in relation to floating and sinking and how the concepts could be integrated in other learning areas, such as literacy and numeracy. The fourth concept, "teacher-oriented classroom practices," prompts understanding on whether teachers are teacher-oriented in the way they conduct their teaching. The last component, “learner-oriented classroom practices,” focused on inquiring from teachers whether their practices were learner-oriented.

One hundred Grade R teachers’ responses were recorded on a computer spreadsheet and later entered into statistical analysis software for computation. Teachers’ responses were presented and analysed on a 5-point Likert scale of *strongly agree (SA), agree (A), neutral (N), disagree (D), strongly disagree (SD).* The responses (*SD, D, N, A, SA*) were assigned rating weight which ranged from 1 to 5 respectively, to make it possible for the means and standard deviations to be calculated. However, in Chapter 4, during the presentation of data, the choice of the 5-point Likert scale was converted to three choices, which are, *disagree*, *neutral* or *agree*. For different responses, percentages and mean scores were calculated and analysed. Standard deviations were also calculated to determine the spread between variables. According to Bell (2002:194), “the use of diagrams and tables can often simplify quite complex data which could take a paragraph or more to explain.” I constructed bar graphs and tables to make data presentation appealing and easier to interpret. Table 3.1 (below) is an example of how data was analysed using descriptive statistics explained above.

For example:

Research question 1: What is the science content knowledge of Grade R teachers’ in Lesotho on selected science concepts?

The following items were extracted from the questionnaire and the averages and standard deviations calculated using the SAS program as follows:

Table 3.2: Sample of teachers' perceived common content knowledge on science concepts

	Questionnaire item (D-stands for disagree, N-stands for neutral and A-stands for agree)	D %	N %	A %		
Item = n	**Teachers' perceived common content knowledge on science concepts**				**Mean**	**S.D**
5	I have enough knowledge about science concepts such as floating and sinking	1	11	88	4.4	0.725
6	I can comfortably plan the concept floating and sinking to teach Grade R learners	1	4	95	4.49	0.674
7	Concepts such as floating and sinking do not require little content knowledge	29	8	63	2.41	1.371
8	Teachers' little science content knowledge does not limit delivery of science	27	13	60	3.53	1.389

Table 3.2 above indicates that a large percentage of teachers (88%) agreed that they had sufficient knowledge about science concepts such as floating and sinking. However, they were diverse in accepting that these required little content knowledge, as the mean score was less than the average score, though not indicated in the excerpt above. The use of standard deviation (SD) and mean scores was essential as the numbers were used to determine the measures of dispersion of a data set. A high SD means that teachers' responses varied greatly from the mean, a low SD that the responses were close or similar to the mean.

The Pearson product-moment correlation or the Spearman's rank correlation coefficient are most widely used measures of association in research. The former assesses a linear relationship between variables while the latter assesses monotonic relationship, whether linear or not (Cohen et al*.,* 2011).

Correlations analysis was conducted in this study. The Spearman's correlation coefficient was used to understand whether there is an association between grade R teachers' science content knowledge and their classroom practices. According to Cohen et al. (2011), the Spearman's Correlation Coefficient, represented by ρ, is a non-parametric measure of the strength and direction of the association that exists between ranked variables. The rank exists between the p-value of +1 or -1. When observations have similar rank the Spearman's correlation will be high between variables if it lies on p-value less than 0.05. Alternatively, when observations have dissimilar rank between variables, the Spearman's Correlation will be low. Teachers' Perceived Common Content Knowledge on Science Concepts (TPCCKSC); Teachers' Perceived Specialised Content Knowledge on Floating and Sinking (TPSCKFS), and Teachers' Perceived Horizon Content Knowledge (TPHCK) were correlated with Teacher-oriented Classroom Practice (TOCP) and Learner-oriented Classroom Practice (LOCP).

Regression analysis was done to strengthen the results found in correlations. According to Cohen et al. (2011), the Pearson product-moment represented by *r*, is a parametric measure of the strength and direction of the association that exists between two variables. Its advantage is that it is easy to use in assessing the association between two variables and the degree to which they correlate. A range of p-value from +1 or -1 is used. When a value is 0 it specifies that there is no association between the two variables, while a value greater than 0 indicates a positive association and a value less than 0 indicates a negative association. Again, TPCCKSC, TPSCKFS and TPHCK were regressed against TOCP and LOCP.

3.5.6.2. **Qualitative data analysis**

Qualitative data analysis used in this study, is interpretive in nature. Central to interpretive analysis is that "the researcher must at all times faithfully reflect the participant's own perspective but in a way that is interpretive in that it attempts to conceptualise what the participant has said, to systematize it and to present a coherent whole" (Coolican, 2014:262). Therefore, that demanded me to understand, explain and interpret participants' experiences, and to have a deep understanding of the generated data. I read data several times before interpreting Grade R teachers' science content knowledge and their practices of the teaching of science. I was able to make sense of their multiple and contrasting perspectives before developing a coherent presentation of Grade R teachers' classroom practices while teaching science (Hennink et al., 2011). Below are details of the ways in which I analysed interviews, observations and document analysis.

Interviews

Teachers' questions required them to demonstrate their common, specialised and horizon content knowledge and how it had influenced their practice. The procedure of interviewing was systematic as I had to analyse pre-observation interviews first, followed by post-observation interviews. After interviewing participants I firstly engaged in the process of analysing data, familiarizing myself with generated data by listening to the audio tapes several times and transcribing data. I read through my transcripts with the purpose of understanding each participant's response and verifying it. Secondly, I coded my data and organised it into themes related to the research questions, then generated sub-themes.

The procedure of organising and categorising data into patterns led into the descriptive and narrative synthesis (Airasian, 2014). The identified patterns were categorised and assigned themes which were used as internal codes. This method of analysis is a content analysis plan (Cohen et al*.,* 2011), by which the main contents of data is summarised into a written report. I paid attention to discovering and understanding my data (Airasian, 2014), which allowed me to comprehend societal actuality in a personal but scientific manner (Zhang & Wildemuth, 2009). Multiple realities from my participants' responses regarding practices they performed during the teaching of science were adhered to and understood to be embedded in their context in their different schools.

Observations

My analysis was generally based on how teachers presented their lessons. I entered details of what I observed from the classroom activities into the prepared observation grid, paying attention to how teachers conducted their lessons. As soon as the lesson was over I filled those gaps on the observation grid on my laptop that I could not record while the lesson was going on. I printed the word-processed record and coded it manually into themes, sub-themes and categories for data analysis and interpretation. I also organised teachers' lesson observations into the themes of interviews and observations, with the purpose of triangulating the results.

Document analysis (lesson plans)

I analysed data using lesson plan that were used by the participants while teaching the concept of floating and sinking. I used the prepared analysis grid to determine the contents of the lesson plan which were crucial. **Appendix D** shows the lesson plan grid analysis tool used in this study. I compared teachers' information on lesson plans to information acquired from interviews and observations. The idea was to improve on the validity of the findings. What teachers said they did was compared to what they actually did in the classroom, as well as what they planned they would do.

The analysis of data was a continuing process and using the content analysis plan was advantageous because it afforded me an opportunity to start analysing data at the early stage of data generation. This allowed me to move back and forth reviewing my data and reconsidering the transcripts and concepts as they developed. The task provided guidance on how to use my data tools more usefully in addressing the research questions (Zhang & Wildemuth, 2009).

3.6. Quality Criteria

A number of criteria were important for gauging the quality of research.

3.6.1. Piloting

Regarded as a miniature scale used for testing research questions and tools (Airasian, 2014), a pilot study was conducted prior to the main one in order to determine whether the methodological procedures, necessary sample and instruments were being used appropriately and adequately (Leedy & Ormrod, 2013). In addition, it was necessary in helping the researcher fine-tune all the planned sections for the main research (Cohen et al., 2011).

As soon as the questionnaire instrument, observational and interview schedules were developed, they were piloted, with the purpose of avoiding possible errors. I piloted four questionnaire forms with Grade R teachers from the nearby schools and not involved them in the main study. Of the four who responded two were observed and interviewed in their schools. Their lesson plans, in which they taught the topic floating and sinking, were analysed. These instruments enabled me to test the nature of questions I used and modification was made with the intention of gathering valuable data when conducting the main study (Airasain, 2014). From the pilot study it was evident that some questions were interpreted differently, wording was not clear or some questions were confusing.

3.6.2. Validity

Validity is deemed a necessary tool for both a quantitative and qualitative research (Cohen et al., 2011). According to Coolican (2014), an instrument is considered valid if it is used to measure what it is intended to, achievable by asking authorities to check whether instruments, for instance, questionnaires forms or interview schedules, are accurate. I asked my colleagues and research authorities to check validity of my research instruments and indicate whether I would gather the expected results. Creswell (2014) adds that researchers need to ask themselves how well matched is the logic of their methods with respect to the research questions and the qualitative and/or quantitative data. To ensure validity, the instruments covered different aspects of teachers' knowledge base on teaching science concepts and how their knowledge influenced their practices. This was realised by the use of questionnaire, observation and verification of what was observed through interviews.

3.6.3. Reliability

The issue of reliability is closely allied to validity, and relies on questions or measures yielding the same results (James, 2014). In this study it was measured by the use of questionnaires, followed by interview schedule, observation protocol, and document analysis. Most researchers use Cronbach Alpha coefficient to test reliability of the questionnaire. The consistency of the items in the questionnaire are measured by Cronbach Alpha to ascertain how close they are in a group (Tavakol & Dennik, 2011). I tested reliability of the questionnaire domains and found answer as displayed in Table 4.2. Hair et al. (2006) suggest the minimal accepted reliability for explanatory research to be 0.5 to 0.6. Values such as 0.8 are regarded high (Cohen et al., 2011). My questionnaire tool is regarded as reliable as it lies between 0.5 and above 0.8.

3.6.4. Trustworthiness

The use of questionnaires surveys, observation and interviews schedules, and document analysis helped ensure trustworthiness of the research findings. When dealing with trustworthiness, Lincoln and Guba as cited in Amankwaa (2016) list the following as the major components:

- **Credibility** "concerns the extent to which the research findings and conclusions can be viewed to be believable" (Nassaji, 2020:428). In order to determine if there were any discrepancies in the findings I established credibility by asking participants to check the transcribed data as to whether it really presented what they intended to say. Again, credibility was reflected by triangulation of multiple data generation methods, which in this case were questionnaires, interviews, observations and document analysis (Nassaji, 2020). Believable as well as convincing findings, along with negative or inconsistence ones, were presented in order to show the trustworthiness of this study.

- **Transferability**. Since the study is pragmatic in nature, the idea of the research study was not generalise but aimed to ensure that science content knowledge of Grade R teachers in Lesotho could be used by other scholars in their research. Nassaji, (2020:428) indicates that "transferability concerns the extent to which the researchers' interpretation or conclusions are transferable to other similar contexts which requires thorough and rich description of the research activities and assumptions". I ensured that the results of this study had rich thick descriptions of the participants regarding their knowledge base, in this case on science understanding and how it influenced their classroom practices.

- **Dependability**. To establish whether this study was dependable, in both phases I ensured credibility of tools by checking with research authorities to find out if my questionnaire was dependable. I also checked whether observational and interview schedules were dependable in measuring the required information. Identified themes were discussed also to ensure they were accurate and dependable. Nassaji (2020:428) emphasises that "such documentations can then be reviewed by an outside researcher to examine their accuracy and the extent to which the conclusions are grounded in the data". I ensured dependability of through checking of documents as to whether they were accurate and responded to the research question.

- **Conformability "**concerns the extent to which others confirm the researcher's interpretations and conclusions" (Nassaji, 2020:428). My supervisors and critical readers confirmed that my study truly measured what it was intended to measure.

3.6.5. Triangulation

According to Creswell and Creswell (2018:265) "triangular techniques in the social sciences attempt to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one standpoint and, in so doing, by making use of both quantitative and qualitative data". In this study, triangulation of method was used because I used mixed methods comprising quantitative and qualitative. The advantage of triangulating these methods is that "the more the methods contrast with each other, the greater is the researcher's confidence" (Creswell & Creswell, 2018:265). For example, the results of the first phase of this study were confirmed by the findings of the second phase. This means that triangulation of methods helps in making the study more comprehensive and fuller. Thus, limitations that could be experienced in one method could be corrected by the other.

In addition, the results brought about by triangulation of methods would help me to be more confident in the research results and to uncover a phenomenon as it is. This complimented my intentions to find out how Grade R teachers knowledge of science influence their practices by asking objective questions based on themes that emerged in the initial phase to develop questions in the second phase.

3.7. Position of the researcher

Råheim et al. (2016) caution about the relationship between the researcher and the researched which often poses a power imbalance between parties and ethical issues. They indicate that the researcher's position can be implicated if data cannot reflect what it is intended to. Besides data not being able to "speak for itself," according to Khawaja and Lerche M∅rck (2009), there is another contribution by the researcher on the ethical nature of the research process.

As an early childhood education educator at LCE, I teach methodology courses to preschool teachers. I pursued this study because early childhood is my specialist area and I have realised misconceptions about some themes in science by in-service teachers in the foundation phase setting. I noted a gap in the literature review and realised that in most cases, when addressing teachers' science content knowledge in the context of elementary, high school or in institutions of higher learning, little attention is given to early childhood.

Most participants in this research were my former students, having been taught by me at LCE. I had interacted with them in many settings, either at classroom level, professional development or even personal level. I "spoke their language" and understood their foundation phase world. As a result, I was conscious that my professional position could be influenced by my interpersonal relationships with them and data to be collected. Aware of my position and how it could hamper its credibility I focussed on whether certain aspects were said to impress me as their former lecturer. This was based on Khawaja and Lerche M∅rck's (2009, 28) view of ethical stance and:

> … constant awareness of and reflection on the multiple ways in which one's positioning as a researcher influences the research process. Studying the other calls for close reflections on one's own position, theoretically, personally, and politically, taking into account one's complicity in either overcoming or reproducing processes of ordering and marginalisation.

My position in this research did not influence the research design, participants, the data collection, analysis or presentation. When administering questionnaire tools and during classroom observation and face-to-face interview, I abided by all ethical guidelines. For instance, in gaining entry to schools I explained the purpose of my research to the school principals and how the teachers' roles would be implicated in the study. I made it clear that my study would not affect school policies and that ethical issues would be observed.

3.8. Ethical Issues

Carrying out a research study indicates that a researcher is entering participants' personal surroundings. Silverman (2011) reminds researchers that they should be aware of the appropriate and inappropriate practices that are generally accepted. Therefore, it was important for me to follow and abide by ethical guidelines necessary in applying for ethical clearance from the University of Free State (UFS). This was approved, though I had to return to the field to obtain more data, therefore

I had to apply for an extension, which was also approved (see **Appendices E1** and **E2**).

After obtaining ethical clearance from the university I requested permission from the Lesotho Ministry of Education (MoET) to meet senior inspector in Maseru district. I presented my request and discussed the purpose of my study, seeking permission to work with the Grade R teachers in different schools so that they would be participants of my study. The inspector gave me his informal consent to carry on with the study. I wrote him a detailed letter explaining my research study and got a go ahead (See **Appendix F** for permission to conduct a research by Ministry of Education).

Upon approval to conduct the study by the Lesotho MoET senior education officer, I met with the Maseru Early Childhood District Officer. I showed her approval from senior education officer, after which we discussed the research study and how I was going to involve Grade R teachers. She arranged my meeting with the National Teacher Trainer who enabled me to talk to preschool teachers. In our meeting we agreed on a slot during their monthly meeting to talk to them about my study. After presenting it I asked one hundred of them to volunteer to take part in the study. Arrangements of when to respond to the questionnaire were made. I made them aware of their right to withdraw at any time they wished, without recrimination. I also assured them that their names would remain confidential even as I asked them to write their telephone numbers on the questionnaire form so that the interesting cases could be contacted for the second phase of the research. I subsequently contacted four of the respondents for the qualitative study. I met their principals, expressed my interest and presented my request (see **Appendix G**: Principal’s letter asking for permission to conduct the research). After some discussion, which was mainly to clarify issues of regarding confidentiality, I was allowed to meet the Grade R teachers, to whom I also issued the consent forms (see **Appendix H**: Consent to participate in the research).

After reading the form with each participant I again clarified that their participation in the study was voluntary and they were free to withdraw at any time and that their participation would be confidential. I assured them that their names would not appear in the report and all the recordings from observations and interviews would be kept safe and destroyed after five years. Rather than use the teachers' real names I consistently use pseudonyms throughout to maintain confidentiality. I arranged for interviews and observations at the time that suited each.

3.9. Limitations of the study

Limitations in a study, usually are "imposed restrictions which are out of researcher's control" (Theofanidis & Fountouki, 2018:156). The aforementioned scholars suggest that possible limitations that could affect the research need to be indicated and that their resolutions should be spelled out. The first limitation of this study was that only Grade R teachers in Maseru were selected. The foundation phase level involves learners from three to eight years of age, with Grade R learners falling within the five-to-six year old group. What happens before or after was not studied, therefore knowledge of science teachers' content for those other years of development is not reflected directly in this study. However, findings from this research would be useful to policy developers and researchers interested in the foundation phase area, especially in Grade R.

Time constraint was another limitation, as participants were observed during classroom sessions. As this was a PhD study I could only collect data for a limited period in order to complete the degree.

Another limitation was that most Grade R teachers were my former students at the LCE. This could possibly influence the results of this study as some participants might not have felt free to reveal their actual experiences. They could have given responses that were meant to impress their former lecturer. Against this background I had to make the participants aware that the situation was different from when they were observed as students, therefore I encouraged them to be as free as possible, while I observed all ethical considerations. Again, different data generation instruments provided for triangulation and credibility of the study.

3.10. Conclusion

Chapter Three has detailed the research design as a blueprint for how I conducted the research. This included decisions on the description of a sampling plan, sources and procedures for collecting data, measuring issues and data analysis plan. I followed a mixed method design which was sequential and explanatory, it allowed me to clearly present and discuss the research data one after the other. Much attention was given to the elaboration of the questions and how they aligned with the theory used to guide the study. The research paradigm underpinning the study was discussed as well as the approaches used. Participants and ethical issues were also discussed. In the next chapter, I present and discuss the data collected, based on the mixed methods approaches as discussed in this chapter.

Chapter 4.
DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1. Introduction

The overall purpose of this chapter is to explore the influence of Grade R teachers' science content knowledge (TSCK) on their classroom practices in Lesotho. Considering that there are many possible science concepts that may be covered in preschool, for this study the focus is on "float and sink". The data presented and analysed were collected from teachers in the Maseru district of Lesotho using a mixed methods design as described in the previous chapter.

Questionnaires for the first part of this study were administered to 100 preschool teachers who had been exposed to science concepts while pursuing a Certificate in Early Childhood Education (CECE) at the LCE. These were followed by interviews and classroom observations of four teachers who had responded to the questionnaires and were subsequently purposely selected. Observation of teachers' lessons was a follow-up to the responses gathered from the questionnaire tool. Interviews were designed to explore the actions and behaviour of teachers during the classroom observations. Lastly, permission was sought to copy the four teachers' lesson plans, on the concepts "float and sink." The lesson plans were only used to triangulate information given during interviews and lesson presentations.

Data analysis, particularly, focused on science teachers' content knowledge and how such knowledge appeared to influence classroom practice. It was guided by both the main research question and the subsidiary questions. A questionnaire was developed to determine the knowledge domains by circling the most appropriate knowledge rank answer on a five-point Likert scale (1= *strongly disagree,* 2= *disagree,* 3= *neutral,* 4= *agree* and 5= *strongly agree*). The following section describes the study sample.

4.2. Description of the study sample

The questionnaire requested basic demographic information on 100 Grade R teachers who had undergone a science training programme at the Lesotho College of Education, results of which are presented in Table 4.1 below.

Table 4.1: Frequency counts for basic demographic information of respondents

Basic demographic information (n = 100)			
Item		Frequency	Percentage
1. **Gender**	Male	4	4%
	Female	96	96%
2**. Age**	20 – 29	21	21%
	30 – 39	44	44%
	40 – 49	25	25%
	50 & Above	10	10%
3.**Teaching experience**	1 – 5	26	26%
	6 – 10	36	36%
	11 – 15	17	17%
	16 & Above	21	21%
4. Highest level of education	Certificate in Early Childhood Education (CECE)	97	97%
	CECE + other certificate	3	3%

All the 100 respondents were preschool teachers working in Grade R classes in schools within the Maseru district in Lesotho. Table 4.1 shows that 96% were females, suggesting that women outnumbered their male counterparts and that Grade R schools in Lesotho could still be dominated by female teachers. The great gender imbalance is consistent with findings by Nelson (2002) that males are generally scarce in preschools because of the fear for the low status of the profession and perhaps even the idea of changing nappies.

The age range of between 30 and 39, constituting the majority of the sample, was also expected because in this case the teachers were mature and stable in making informed decisions, including the kind of employment they wished for. Only 21%

were between 20 and 29+, attributable to their being an active age group that is trying to fit into the world of employment. Data also shows a relatively low 50+ age range, the possible reasons being two-fold, firstly because the professional training of preschool teachers in Lesotho has only recently started, so the older age group could have not benefited from it. Secondly, most of the older teachers showed little interest in gaining access to teacher training or did not qualify for admission to the training.

Most of the teachers were experienced, 26% having taught for one to five years, 36% percent for six to ten years, 17% for 11-15 years, while 21% had taught for 16 years or more. This data imply that the teachers selected had ample teaching experience in Grade R schools in Lesotho. The teaching experience was significant because, whilst Rice and Kitchel (2017) found that it had an effect on teacher content knowledge, I wished to find out whether that was the case in this context and how that would shape the Grade R teachers' classroom practices.

The sample had all the required minimum qualification for teaching at this level, that is, the Certificate in Early Childhood Education, whilst 3% had more than the required certificate. The study still found it significant to examine the impact that the qualification could possibly have on science learning in early childhood education.

4.3. Reliability and validity of the study

Cohen et al*.* (2011) posit that reliability and validity differ in meaning in quantitative and qualitative research, whilst Leedy and Ormrod (2013) regard reliability in quantitative research as consistency, in line with precision and accuracy over time. This occurs when what is measured yields similar results with different groups of respondents. To test for reliability, the questionnaire instrument was piloted with 4 teachers in the Maseru district. The teachers had the same qualification as the main respondents but did not form part of the main study. Cohen et al. (2011) add that reliability in qualitative research is concerned more with dependability, meaning that data collected is related to the natural setting in which it was found. Reliability was assured through the use of different instruments, for instance, interviews conducted a few days or a day before the classroom observation.

The quantitative data were first cleaned, coded and entered into a spreadsheet before being transferred into the Statistical Analysis Software (SAS). The first analysis was descriptive, with frequencies reported. Cohen et al. (2011:606) write that “descriptive statistics describe and present data with no inferences or predictions.” The 100 Grade R teachers’ descriptive statistics were calculated and their demographic data generated from four items or questions. These were used as control variables, and the others were recorded as either dependent or independent variables.

All the questions were tested for reliability using the Cronbach’s alpha coefficient which measures the consistency of items in a questionnaire to ascertain how closely related they are in a group (Tavakol & Dennik, 2011). Although widely used, Gliem and Gliem (2003) argue that there is no fixed rule regarding the score of reliability to be considered acceptable. On the other hand, Hair et al. (2006) recommend the minimally acceptable reliability for explanatory research to be 0.5 to 0.6. Higher values, such as 0.8, often show that the measure is highly reliable (Cohen et al., 2011). Table 4.2 below shows a reliability test for the five (5) domains of the study.

Table 4.2: Reliability test for the five (5) domains of the study

Domain	Cronbach's Alpha	Number of items
Teachers' Perceived Common Content Knowledge on Science Concepts (TPCCKSC)	0.77	19
Teachers' Perceived Specialised Content Knowledge on Floating and Sinking (TPSCKFS)	0.55	10
Teachers' Perceived Horizontal Content Knowledge (TPHCK)	0.62	10
Teacher-Oriented Classroom Practices (TOCP)	0.77	20
Learner-Oriented Classroom Practices (LOCP)	0.82	11

The scale used was reliable and useful in the context of an explanatory research design (Hair et al*.,* 2006). The Cronbach alpha coefficient calculated for this data varied from a value of 0.55 to a reliability of 0.82, which is suggested high. The 0.62 is minimally reliable, with Cohen et al. (2011) arguing that the coefficient of $0.6 \leq \alpha \leq 0.69$ is still considered "acceptable" for the content of an instrument. Teachers' perceived specialised content knowledge on floating and sinking had a low value of 0.55, which is still acceptable for explanatory research as stipulated by Hair et al*.* (2006). This suggests that the questionnaire instrument had relatively good internal consistency.

To confirm reliability in the qualitative part, I piloted the semi-structured interview questions with two teachers who met the same requirements as the respondents of the study. The observation protocol tool was sourced manually from the internet and adapted to match my intention of finding out how teachers' science content knowledge influenced their classroom practices. What teachers said they knew about floating and sinking concepts was triangulated with what they did in the classroom and reflected in their lesson plans.

4.4. Quantitative analysis

The teachers' responses regarding their science content knowledge are described in this section. The questionnaire used to elucidate this information had 74 items, the first four of which were based on demographic details of respondents, 19 to determine Teachers' Perceived Common Content Knowledge on Science Concepts (TPCCKSC), 10 to determine Teachers' Perceived Specialised Content Knowledge on Floating and Sinking (TPSCKFS), and 10 to examine Teachers' Perceived Horizon Content Knowledge (TPHCK). Some items were also used to find information on teachers' classroom practices, with the intention of revealing whether they were teacher-oriented or learner-oriented. Accordingly, 20 items were used to inquire about Teacher-Oriented Classroom Practices (TOCP) and 11 items used to determine Teacher-Oriented Classroom Practices.

The responses to the questionnaires were presented and analysed on a 5-point Likert scale of *strongly disagree* (SD), *disagree* (D), *neutral* (N), *agree* (A) and *strongly agree* (SA). Each response (SD, D, N, A, SA) was given a weighting ranging from 1 to 5 respectively to allow for the calculation of means and standard deviations. This meant that the mean of 1 would stand for SD whilst a mean of 5 or close to 5 would mean SA. However, for the purpose of analysis, the Likert scale was then collapsed from five choices to three, being, "*disagree*", "*neutral*" or "*agree*". The response concept that showed disagreement was categorised on averages of 1.0 to 2.9 or below 3, the neutral stood out to be 3 while an agreement ranged from 3.1 to 5.0. Therefore, this scale serves as a decision point for positive, neutral and negative means. The standard deviations (SD) ranging from 0.1 to 0.99 were considered to mean a cluster around the mean whereas SD of 1.0 and more indicated a wide variation from the mean.

Although not carried out on the teachers' questionnaire for reliability purposes, analysis on items that required TPSCKFS was calculated in parts for some items were positively scored and aligned well with the Likert scale, while the negative responses were purposively reversed so that they would score higher points as expected. The negative items are those for which we expected a low score because the respondents would have disagreed with the statement. If they disagreed they scored highly, but if they agreed they had a low score. In this way, I had reverse scoring. For instance:

Item # 31. Clay that is shaped like a plate will sink in water.

I expected teachers to disagree because when one reshaped clay into a plate it increases the surface area and will thus float.

Item # 32. Many stones on a tray will sink in water.

Here, I expected teachers to disagree because the idea of this experiment was to show that one stone by itself will sink in water but when one puts it on a tray with a larger surface area it will float.

The mean score (M) and standard deviation (SD) were calculated and used for each item. For some items percentages were calculated for different responses. Bar graphs were generated to provide a better understanding of data presented. The Spearman's rank correlation coefficient and the Pearson product-moment correlation were also used to correlate between teachers' content knowledge and their classroom practices. They were used to understand whether there is a relationship between Grade R teachers' science content knowledge and their classroom practices. The perceived teachers' science content knowledge was assessed in part by items in sections B, C and D of the questionnaire, while their classroom practices were assessed through items in sections E and F.

4.5. Findings organised by research questions

Teachers' responses regarding their content knowledge and how it influences their practices are explored in this section.

4.5.1. Research question 1

This section presents findings on the question:

What is the science content knowledge of Grade R teachers in Lesotho on selected science concepts?

The first research question asked Grade R teachers in Lesotho about their perceived science content knowledge on floating and sinking concepts. Table 4.3 shows teachers' responses.

Table 4.3: Teachers' perceived common content knowledge on science concepts

	Questionnaire item (D-stands for disagree, N-stands for neutral and A-stands for agree)	D	N	A		
Item = n	**Teachers' perceived common content knowledge on science concepts**	**%**	**%**	**%**	**Mean**	**S.D**
5	I have enough knowledge about science concepts such as floating and sinking.	1	11	88	4.4	0.725
6	I can comfortably plan the concepts floating and sinking to teach Grade R learners.	1	4	95	4.49	0.674
7	Concepts such as floating and sinking do not require little content knowledge.	29	8	63	2.41	1.371
8	Teachers' little science content knowledge does not limit delivery of science concepts.	27	13	60	3.53	1.389
9	If one is well-informed in science he or she can implement activities easily.	3	6	91	4.47	0.822
10	Knowledge of science content involves facts.	5	10	85	4.2	0.888
11	Knowledge of science content involves step-by-step process.	3	3	94	4.39	0.777
12	Knowledge of science content involves science skills.	2	13	85	4.38	0.827
13	I can communicate steps in science experiments as required.	3	13	84	4.23	0.827
14	I am comfortable to answer Grade R learners' questions on science.	0	6	94	4.5	0.611
15	The experience I have in teaching helps me to understand science concepts.	1	5	94	4.51	0.643
16	I rely on textbooks to understand science concepts.	21	23	56	3.52	1.096
17	I rely on curriculum guide to understand science concepts.	20	19	61	3.68	1.136
18	I consult my colleagues to clarify science concepts I do not know.	5	5	90	4.27	0.851
19	The tertiary education exposed me to science concepts.	7	14	79	4.09	0.986
20	High school education exposed me to science concepts.	15	25	60	3.62	1.061
21	Science textbooks exposed me to science concepts.	12	15	73	3.83	1.006
22	I took science as a specialised course at the college.	26	24	50	3.47	1.218
23	I took science as a general course at the college.	8	26	66	3.89	1.034
	TOTAL AVERAGE				**3.99**	**0.944**

The results for item 15 with the highest mean, indicate that most Grade R teachers (94%) regarded their experiences in teaching as having an influence on their ability to understand science concepts. For example, some respondents were able to reveal that “The experience I have in teaching helps me to understand science concepts,” as evidenced by the highest mean score of 4.51 and a standard deviation of 0.643. The low standard deviation of 0.643 indicates that the results are closer to the mean score. The results concur with the observation of Rice and Kitchel (2017) that teaching experience contributes greatly to teachers CCK as it develops over time.

Another item which showed a high response was item 6, which was probed by the statement “I can comfortably plan the concepts floating and sinking to teach Grade R learners.” Its mean score was 4.49 with standard deviation of 0.674, showing that teachers perceived that they were able to plan lessons on the floating and sinking concepts comfortably, which is expected of teachers who had undergone teacher training. This was further examined in their lesson preparation to see whether planning had been as suggested by these results.

Item 7, “Concepts such as floating and sinking do not require little content knowledge,” obtained the lowest mean of 2.41, with SD of 1.371. Although Grade R teachers had mixed opinions, as indicated by a relatively high standard deviation, the major concern was the relatively low mean score. It refutes Abd-El-Khalick’s (2012) interpretation that science concepts require sufficient content knowledge.

Items 8 and 9 asked the same question, though phrased differently with the intention of finding out whether the teachers noticed and thus testing their credibility. Interestingly, however, data showed varying responses from the Grade R teachers. The standard deviation for item 8 was 1.389, which indicated that teachers’ response varied widely from the mean while SD for item 9 was 0.822, which was relatively low and indicated that teachers’ responses clustered around the mean. The items intended to find out from the teachers whether they agreed that if one has limited science content knowledge he/she will definitely have difficulty delivering the content, as raised by Kavalari et al. (2012). However, most teachers were in agreement with what Kavalari and her colleagues had expressed.

There are different ways for teachers to obtain information they use in class to teach science. Figure 4.1 below indicates that teachers in this study source out information on the content floating and sinking from text books or curriculum guides. The results indicated that teachers' responses on how they obtain information vary greatly.

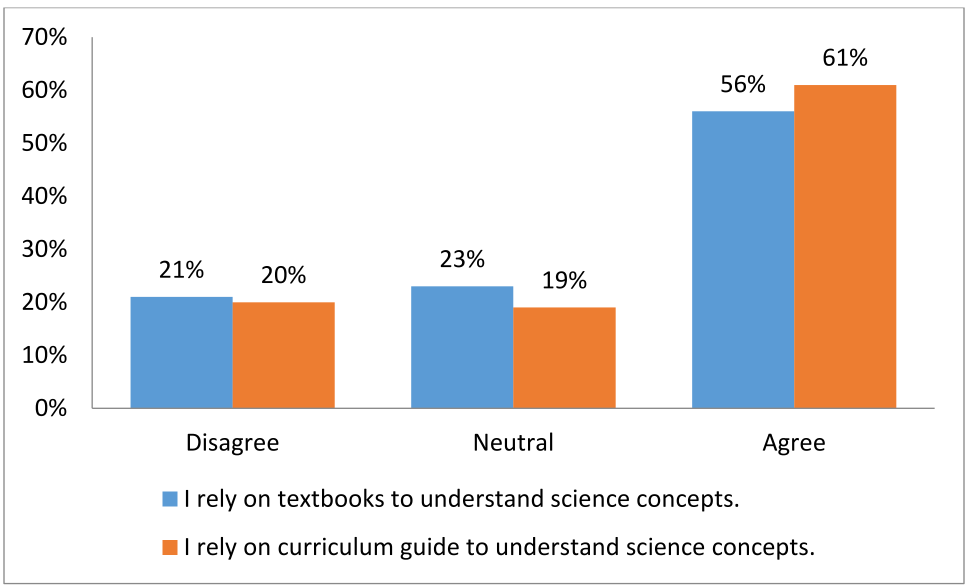


Figure 4.1: Outsourcing information on science concepts

Although Table 4.3 shows that a large number of teachers (79%) agreed that tertiary education exposed them to knowledge of science concepts greatly, a few (14%) were not sure whether they had sufficient exposure or not while a small number (7%) disagreed with the view. This was set off by item 19, which stated "The tertiary education exposed me to science concepts." Literature shows that college-acquired knowledge contributes to the attainment of content knowledge as its primary goal is to develop teachers' knowledge by exposing them to theory and practice (Kelly & Tannehill, 2012).

For items 22 and 23 on Table 4.3, 50% of teachers said that they considered science as a specialised course. However, I observed that this response might have been provoked perhaps by lack of understanding on the meaning of generalised versus specialised course. Furthermore, according to the Lesotho College of Education (2020), science activities by CECE students are treated as a general course for this qualification. Data showed that almost a quarter of teachers were not sure whether they specialised in science, raising fundamental questions as to whether they really understood what was meant by specialised or generalised course.

Although there were few teachers who could not decide on some statements asked, the results in Table 4.3 show that teachers had sufficient CCK, as expected. These results align with what Campton and Stephenson's (2014) suggest by indicating that a well-educated adult or teacher in this case should be able to have correct answers, accurate information and define terms and concepts correctly. Undecided teachers, therefore, could mean that their CCK is questionable.

In response to the first secondary question, teachers were asked about their specialised content knowledge (SCK) on floating and sinking. Table 4.4 shows the results for teachers' perceived specialised content knowledge based on positive responses. The average mean score for this part was 3.8, while the average SD was 1.109.

Table 4.4: Teachers' perceived specialised content knowledge on floating and sinking (positive items)

	Questionnaire item (D-stands for disagree, N-stands for neutral and A-stands for agree)	D	N	A		
Item =n	**Teachers' perceived specialised content knowledge on science concepts (POSITIVE ITEMS)**	**%**	**%**	**%**	**Mean**	**S.D**
24	Things float if they are 'supported by water' (or air) due to an upward force.	3	12	85	3.77	1.07
25	A fish can be said to be floating in water even if it is not on the surface.	19	20	61	3.8	1.06
26	A nail will sink in water even if its weight can be smaller than a log.	10	6	84	3.87	1.008
27	A ball like clay will sink in water.	19	9	72	3.83	1.34
28	All objects that float must contain some trapped air.	31	16	53	3.73	.907
29	One will feel an up-thrust force while dipping a ball in water.	8	28	64	3.9	1.27
	TOTAL AVERAGE				**3.8**	**1.109**

Most of the responses were equal or higher than the total average mean score as reflected on items 25, 26, 27 and 29. The aggregate mean score for this domain is not very high, suggesting that Lesotho Grade R teachers may have insufficient SCK. The SD for items 27 and 29 were higher than the total average mean scores which means that teachers' thoughts were rather diverse. Neutral answers indicate that teachers were not decided as to whether they should agree or disagree with the statements. This adds to teachers unsatisfactory SCK perceived by Grade R teachers. The table details responses below to indicate Grade R teachers' perceived specialised content knowledge on floating and sinking, but the items were of the negative form. Therefore, the manner in which they were scored is in reverse order.

Table 4.5: Teachers' perceived specialised content knowledge on floating and sinking (negative items)

	Questionnaire item (D-stands for disagree, N-stands for neutral and A-stands for agree)	A	N	D		
Item=n	**Teachers' perceived specialised content knowledge on science concepts (NEGATIVE ITEMS)**	**%**	**%**	**%**	**Mean**	**S.D**
30	Light objects float regardless of their size, shape or the type of material used to make them.	79	4	17	3.53	1.53
31	Clay that is shaped like a plate will sink in water.	69	7	24	3.50	1.59
32	A true floating object must be completely above the surface of the liquid.	73	10	17	3.10	1.40
33	Many stones on a tray will sink in water.	75	6	19	3.53	1.10
	TOTAL AVERAGE				**3.42**	**1.44**

The average mean score for the above Table is 4.5 is 3.42 and the average SD is 1.44. The low aggregate mean score for this domain means that teachers may indeed have insufficient SCK. Three items (30, 31 and 33) have mean scores higher than the total average mean. The frequency count for each item in Table 4.5 suggests that teachers seem to have little understanding of floating and sinking concepts as they scored highly on the negative items whereas they were expected to disagree with the statements. The spread for item 31 appeared wide since the standard deviation was the largest (1.59) compared to other items under the same construct. Notable are the mixed thoughts that surfaced between the respondents. Though most responded adequately on those items the results show that some teachers were not conversant with aspects of the floating and sinking content. For instance, most (73%) *agreed* on item 32 that "A true floating object must be completely above the surface of the liquid," but this is not true because some objects might be immersed in water by half or a quarter of their shape.

The next table shows teachers' perceived horizon knowledge, and displays the results postulated by answering the first secondary research question, which was meant to find out if teachers had knowledge of science content with the selected concepts of floating and sinking taught in Grade R.

Table 4.6: Teachers' perceived horizon knowledge on science concepts

	Questionnaire item (D-stands for disagree, N-stands for neutral and A-stands for agree)	D	N	A		
Item =n	**Teachers' perceived horizon content knowledge on science concepts**	**%**	%	**%**	**Mean**	**S.D**
34	I engage literature to teach floating and sinking.	20	13	67	3.61	1.31
35	I interact technology while teaching floating and sinking.	15	6	79	4.00	1.073
36	I relate floating and sinking to everyday life.	12	13	75	4.06	1.081
37	I integrate numeracy while teaching the topic floating and sinking.	8	4	88	4.30	.980
38	I ask learners to draw what they observed while doing floating and sinking activity.	12	9	79	4.06	1.071
39	I create opportunities for learners to engage in play activities to emphasise the concepts "float and sink"	5	40	55	4.49	.628
40	There should be a spiral relationship of science concepts taught in early childhood to high school.	3	11	86	4.20	.791
41	Playing with water by preschool learners serves as a foundation for floating and sinking objects.	2	2	96	4.48	.643
42	Preschool learners will understand the concept of density when they are in higher grades.	3	4	93	4.13	.661
43	Preschool learners will know the force that pushes objects to float when they are in higher grades.	3	1	96	4.42	.713
	TOTAL AVERAGE				**4.18**	**0.895**

In Table 4.6 above, teachers appear to be clear on what learners should be familiar with before they can engage in floating and sinking activities, as this was highlighted by 96% of the respondents. This concurs with the explanation by

Jacobsen et al. (2013) that horizon knowledge caters for what comes before the concept that is dealt with. This is corroborated by more positive answers on item 42, showing that teachers are also aware of what would be catered for after a certain concept is taught. In this case, we can talk about the concept of density for example which will be introduced to learners later in their studies.

In contrast, Table 4.6 also indicates that teachers were undecided on interacting literature and technology when teaching the concepts floating and sinking. This is reflected by a relatively high SD of 1.31 and 1.073 indicating a wide variation from the mean signifying that teacher's perceptions were diverse. In one area, most indicated that they engaged numeracy while teaching the topic floating and sinking, as data reflected 88% *agreed* with the mean score of 4.3. Item 39 required teachers to confirm whether they created opportunities for learners to engage play activities in emphasis of floating and sinking concepts. The item had the highest mean score of 4.49, which is not surprising because playful learning in ECD is suggested as the key element in helping children make sense of what they are learning (Palaiologou, 2016).

The findings for teachers' horizon content knowledge reveal that teachers are heterogeneous. Some *agreed* with the statements while others were *not sure* whether the items were correct or not. Therefore, their horizon content knowledge for this sample was diverse even as it converged towards higher HCK.

4.5.2. Research question 2

This section presents the responses for the second research question: How do Grade R teachers teach the selected science concepts to their learners?

Table 4.7 (below) shows responses generated from Section E of the questionnaire. The aim was to establish the extent to which teachers' classroom practices were teacher-oriented.

Table 4.7: Teacher-oriented classroom practices

	Questionnaire item (D-stands for disagree, N-stands for neutral and A-stands for agree)	D	N	A		
Item =n	**Teacher-oriented classroom practices**	**%**	**%**	**%**	**Mean**	**S.D**
44	I tell my learners the concepts floating and sinking.	23	8	69	3.75	1.340
45	I interact with my learners while teaching them about the topic floating and sinking.	76	7	17	2.08	1.152
46	I expect my learners to accept the ideas that I provide them on the topic floating and sinking.	34	21	45	3.22	1.227
47	I prefer that my learners hold their personal opinion during classroom experiences.	33	7	60	3.55	1.336
48	I only provide examples of floating and sinking objects as described in the curriculum guide.	49	17	34	2.85	1.313
49	I explain the steps to follow when doing activities with learners.	14	8	78	4.03	1.077
50	I look at the activities from the books.	34	15	51	3.26	1.315
51	I bring objects that can float and sink in the classroom.	4	5	91	4.45	.809
52	I ask questions that establish learners' previous knowledge.	4	1	95	4.45	.796
53	I demonstrate floating and sinking concepts to the learners.	16	8	76	4.01	1.176
54	I predict for the learners the objects that will float or sink when teaching the concepts of floating and sinking.	42	8	50	3.05	1.41
55	I write learners' predictions about things that float and the ones that sink in water.	19	12	69	3.68	1.127
56	I can see learners' common errors while classifying floating and sinking objects and help them.	11	13	76	3.92	1.098
57	I classify objects that float and objects that sink in water.	18	10	72	3.85	1.218
58	I record observed objects which float and sink in water.	3	11	86	4.20	.752
59	I can assist learners to identify connections between floating and sinking.	4	8	88	4.16	.775
60	I ask learners questions on the work done.	2	3	95	4.56	.700
61	I give learners homework on the work done	14	13	73	3.96	1.118
62	I ask learners to work individually.	18	11	71	3.77	1.127
63	I give feedback and conclude the lesson.	3	0	97	4.62	.693
	TOTAL AVERAGE				**3.77**	**1.078**

The domain total average mean score for teacher-oriented classroom practices is 3.77, while the total average standard deviation is 1.078. Items 44, 45, 46, 47, 48, 50, 54 and 55 are below the average mean score, while items 49, 51, 52, 53, 56 to 63 are higher than the indicated average mean score. Item 44 shows that most of the teachers *agreed* that they tell their learners about the concepts floating and sinking. This is indicated by 69% of the respondents who indicated that they gave the information to learners. Since teachers tell learners what to do in the classroom, this translates into teachers being in control and not eliciting learners' knowledge. This is against Schreurs and Dumbraveanu's (2014) proposal that the role of the teacher, in a learner-centred classroom, is more of a facilitator who guides learning than of a dictator. Data reveals that only 23% of the respondents were not teacher-oriented while 8% could not decide whether they tell their learners what to do or not. This shows that teachers' opinions vary.

Grade R teachers appeared to interact well with their learners. 76% of the respondents indicated that they did not agree with the statement that "I do not interact with my learners while teaching them about the topic floating and sinking." This shows that not all classrooms are teacher-oriented because there are some incidences when teachers use learner-oriented practices.

There were mixed opinions on item 46, which reads "I expect my learners to accept the ideas that I provide them on the topic floating and sinking." The responses are reflected in the graph below:

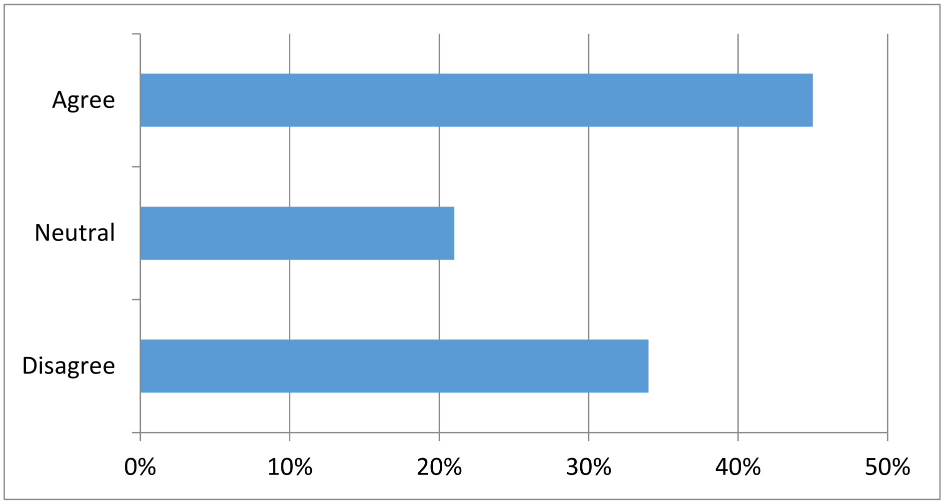


Figure 4.2: Expecting learners to accept provided ideas

Thirty-four percent of the respondents *disagreed* with the indication of learners accepting their ideas on the topic "float and sink," whilst 21% were *neutral* and 45% *agreed*. The results for item 46 show that teachers' classrooms were divided between being both learner-oriented and teacher-oriented.

It is noticeable from Table 4.7 that for item 47, teachers had various opinions regarding how they preferred learners to voice their opinions during classroom discussions. This is shown by the high standard deviation of 1.336, meaning that opinions were spread further from the mean.

Literature based on post-Piagetian theory indicates that preschool children have organizing structures that allow them to make predictions about data at hand (Guo et al*.,* 2015). Remarkably, however, item 54 elicited diverse responses from Grade R teachers on the statement "I predict for the learners the objects that will float or sink when teaching the concept of floating and sinking". Fifty percent of the respondents agreed with the statement while eight percent were not sure what they did. Forty-two percent were clear that they did not predict for the learners the objects that float and sink. If half of the respondents were sure that they predicted the learners as revealed by the data this is evidence that classrooms were largely teacher-oriented and perhaps did not give learners the chance to predict what would happen. The mean score for this item was 3.05, which was below the average mean score with the high standard deviation of 1.41 because teachers' responses were mixed.

The organizing structures that allow young children to organise materials and explain their experiments were somehow compromised by the teachers in the sample. Guo et al.'s (2015) declaration is supported by items 57 and 58, which indicate that Grade R teachers classified, recorded and observed floating and sinking objects. The results also show that teachers used mainly teacher-centred approaches with 72% *agreeing* with item 57, which said "I classify objects that float and objects that sink in water." A total of 86% agreed with item 58 that read "I record observed objects which float and sink in water." Both items had high mean scores of 3.85 and 4.20 respectively, above the average mean score.

In the process of teaching and learning about the concepts "float and sink," Grade R teachers *agreed* with most of the processes. For instance, most *agreed* that they assisted learners in identifying connections between floating and sinking. They asked questions on the work carried out, and gave feedback. They also gave homework, and asked learners to work individually then conclude the lessons. Though there was an agreement that teachers used the aforementioned tasks with learners, some did *not agree* with the notion. In an ECD setting, teachers stimulate, direct and guide learning, as recommended by Isaacs (2018), so some activities led by teachers would always take place. This is reflected in some prominent ECD pioneers, such as Maria Montessori, who emphasise that teachers should be present to guide while learners do their own work independently. It is expected that teachers, together with the learners wrap-up the lesson, not teachers alone. The results from the teaching of science indicate that teachers used both teacher-oriented and learner-oriented classroom practices.

Table 4.8 below indicates responses generated from Section F of the questionnaire. The aim of this section is to establish whether teachers' classrooms are learner-oriented.

Table 4.8: Learner-oriented classroom practices

	Questionnaire item (D-stands for disagree, N-stands for neutral and A-stands for agree)	D	N	A		
Item=n	**Learner-oriented classroom practices**	**%**	**%**	**%**	**Mean**	**S.D**
64	I encourage learners to tell me things that float or sink first.	9	0	91	4.36	.916
65	I encourage learners to bring objects that can float and sink in the classroom.	3	0	97	4.46	.744
66	I encourage learners to think about objects that will float or sink when teaching the concepts “float and sink”.	8	1	91	4.29	.880
67	I encourage learners to classify objects that float and objects that sink in water.	4	2	94	4.43	.728
68	I encourage learners to carry out activities of floating and sinking objects.	5	8	87	4.24	.806
69	I encourage learners to record observed floating and sinking objects by drawing.	16	14	70	3.79	1.085
70	I encourage learners to assess the work done by others after recording.	24	17	59	3.47	1.132
71	I ask learners to work in pairs or small groups.	2	2	96	4.55	.687
72	I give learners chance to explain their answers.	2	6	92	4.41	.740
73	I ask learners to record their findings.	19	24	57	3.64	1.151
74	Learners are given chance to observe each other while doing activities.	12	6	82	4.03	1.058
	TOTAL AVERAGE				**4.15**	**0.902**

From Table 4.8 above, the average mean score was 4.15 and the SD 0.902. This high mean score indicates that teachers had a tendency to use learner-oriented classroom practices. However, they had mixed responses as items 69, 70, 73 and 74 were below the domain mean average score of 4.15. This could mean that not all teachers used learner-oriented classroom practices. Items 64, 65, 66, 67, 68, 71 and 72 were higher than the domain mean average score, which indicates high tendency for teachers to use learner-oriented classrooms practices. Given the results from this table it can be concluded that although the average mean of 4.15

indicates that teachers used leaner-oriented classrooms practices, some items suggest otherwise and confirm the mixed results in the previous section on teacher-centred approaches.

4.5.3. Research question 3

To answer research question 3, I first conducted a correlation analysis to establish the relationships between the various components of content knowledge with the teachers' classroom practices. Table 4.9 below shows how spearman correlation coefficients between domain averages were tested.

Table 4.9: Spearman correlation coefficients (p-values) between questionnaire domain averages (N=100)

	TPCCKSC	**TPSCKFS**	**TPHCK**	**TOCP**	**LOCP**
TPCCKSC	1.00000	0.36341 (0.0002)	0.44647 (<.0001)	0.12680 (0.2087)	0.28577 (0.0039)
TPSCKFS	0.36341 (0.0002)	1.00000	0.12299 (0.2228)	0.16194 (0.1075)	0.12384 (0.2196)
TPHCK	0.44647 (<.0001)	0.12299 (0.2228)	1.00000	0.19902 (0.0471)	0.42819 (<.0001)
TOCP	0.12680 (0.2087)	0.16194 (0.1075)	0.19902 (0.0471)	1.00000	0.40038 (<.0001)
LOCP	0.28577 (0.0039)	0.12384 (0.2196)	0.42819 (<.0001)	0.40038 (<.0001)	1.00000

*Significant at $p<0.05$

Teachers' Perceived Common Content Knowledge on Science Concepts (TPCCKSC); Teachers' Perceived Specialised Content Knowledge on Floating and Sinking (TPSCKFS); and Teachers' Perceived Horizontal Content Knowledge

(TPHCK) have no combined influence on Teacher-Oriented Classroom Practices (TOCP)

The results presented in Table 4.9 show a weak correlation between Teachers' Perceived Common Content Knowledge on Science Concepts (TPCCKSC); with Learner-Oriented Classroom Practices (LOCP) because the Spearman's Correlation Coefficient (r) is 0.28577, but it is statistically significant with the p-value of (p= 0.0039). Conversely, the correlation between TPCCKSC and Teacher-Oriented Classroom Practices (TOCP) is weak (r=0.12680; p= 0.2087). Teachers' Perceived Specialised Content Knowledge on Floating and Sinking (TPSCKFS) has both weak correlation with TOCP and LOCP because their p-values are (p=0.1075) and (p= 0.2196) respectively. On the other hand, Teachers' Perceived Horizontal Content Knowledge (TPHCK) has a weak correlation with TOCP (r=0.19902; p=0.0471) but a moderate correlation with LOCP (r=0.42819; $p<0.0001$).

To test further the influence of the Grade-R teachers' content knowledge on their classroom practices, I also did a regression analysis to explore four possible predictive models on the relationship between the Grade-R teachers' content knowledge and their classroom practices.

Firstly, I sought to answer the question: What is the combined influence of Lesotho Grade R teachers' science content knowledge on their learner-oriented classroom practices?

Table 4.10: Combined influence of Lesotho Grade R teachers' science content knowledge on their learner-oriented classroom practices

Model	*Sum of Squares*	*Df*	*Mean Square*	*F*	*Sig.*	*Remark*
1 Regression	483.610	3	161.203	4.002	.010[b]	Significant
Residual	3705.380	92	40.276			
Total	4188.990	95				
*R=.340[a] **Adjusted R Square= .012	R Square= .115	Std. Error of Estimate = 6.34633	Durbin Watson 1.829			

a. Dependent Variable: Learner-Oriented Classroom Practices (LOCP)

b. Predictors: (Constant), Teachers' Perceived Common Content Knowledge on Science Concepts (TPHCK); Teachers' Perceived Specialised Content Knowledge on Floating and Sinking (TPSCKFS); Teachers' Perceived Horizontal Content Knowledge (TPHCK).

Table 4.10 above presents the results of the multiple regression analysis computed to answer research question three. The outputs of the multiple regression analysis presented R square as .115 (11.5%), and R=.340. This result implies that Teachers' Perceived Common Content Knowledge on Science Concepts; Teachers' Perceived Specialised Content Knowledge on Floating and Sinking; and Teachers' Perceived Horizontal Content Knowledge accounted for 11.5% of the variance in Learner-Oriented Classroom Practices in Grade R schools in Lesotho. This combined influence of the predictors was significant on LOCP ($F_{(3,92)} = 4.002$; $P < 0.05$) reflected by *p*-value of $p = .01$ which is less than 0.05 . The Durbin-Watson (d) value of 1.829 confirms that there is no auto correlation in the data processed for this study because it falls between the critical values of $1.5 < d < 2.5$. This result implies that there are other variables that constituted 88.5% which affected Grade R teachers' Learner-Oriented Classroom Practices in Lesotho that were not addressed in this study.

Secondly, I analysed the data to explore the question on: What is the combined influence of Lesotho Grade R teachers' science content knowledge on their teacher-oriented classroom practices?

Table 4.11: Combined influence of Lesotho Grade R teachers' science content knowledge on their teacher-oriented classroom practices

Model	*Sum of Squares*	*Df*	*Mean Square VIF*	*F*	*Sig.*	*Remark*
1 Regression	26012.596	3	8670.865	1.175	.323[b]	Not Significant
Residual	678665.362	92	7376.797			
Total	704677.958	95				
*R=.192[a] **Adjusted R Square= .006	R Square= .037	Std. Error of Estimate = 85.88828				

a. Dependent Variable: Learner-Oriented Classroom Practices (LOCP)
b. Predictors: (Constant), Teachers' Perceived Common Content Knowledge on Science Concepts (TPHCK); Teachers' Perceived Specialised Content Knowledge on Floating and Sinking (TPSCKFS); Teachers' Perceived Horizontal Content Knowledge (TPHCK).

Table 4.11 above shows the results of the multiple regression analysis computed to answer question two. The outputs of the multiple regression analysis presented R square as .037 (3.7%), and R=.192. This result implies that Teachers' Perceived Common Content Knowledge on Science Concepts; Teachers' Perceived Specialised Content Knowledge on Floating and Sinking; and Teachers' Perceived Horizontal Content Knowledge have no combined influence on Teacher-Oriented Classroom Practices in Grade R schools in Lesotho. This combined influence of the predictors did not significantly influence TOCP ($F_{(3,92)} = 1.175$; $P > 0.05$) reflected by p-value of $p = .323$ which is higher than 0.05. The Durbin-Watson (d) value of 1.971 confirms that there is no auto correlation in the data processed for this study because it falls between the critical values of $1.5<d<2.5$. This result implies that the predictor variables have no substantial influence on Grade R teachers' Teacher-Oriented Classroom Practices in Grade R schools in Lesotho.

Thirdly, I examined data which sought to explore: What is the relative influence of Lesotho Grade R teachers' science content knowledge on their learner-oriented classroom practices?

Table 4.12: Relative influence of Lesotho Grade R Teachers' science content knowledge on their LOCPs

Model	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.	Collinearity Statistics Tolerance	VIF
(Constant)	27.260	8.642		3.154	.002		
TPCCKSC	.028	.092	.033	.308	.759	.840	1.191
TPSCKFS	-.076	.162	-.046	-.470	.640	.999	1.001
TPHCK	-.461	.153	.323	3.021	.003	,839	1.191

a. Dependent Variable: Learner-Oriented Classroom Practices (LOCP)

Table 4.12 above confirms that TPHCK (B= .323, t=3.021, p<0.05) had the most relative influence on LOCP. The *p*-value for TPHCK is significant because it is *p* = .003 which is less than our threshold which is *p*<0.05. TPCCKSC (B= .033, t=.308, p>0.05) and TPSCKFS (B= -.046, t= -.470, p>0.05) had no significant relative influence on LOCP even their p-values are higher than p>0.05, they are *p* = .759 and *p* = .64 respectively. The analysis further determined the existence of multi-collinearity among the predictor variables. The values of collinearity statistics presented on Table 4.12 confirmed the non-existence of multi-collinearity among the predictor variables as the tolerance and the Variance Inflation Factor (VIF) were normal because if the VIF is equal to 1 there is no multi-collinearity among factors, but if the VIF is greater than 1, which is the case, the predictors may be moderately correlated.

Lastly, my analysis necessitates to investigate: What is the relative influence of Lesotho Grade R teachers' science content knowledge on their teacher-oriented classroom practices?

Table 4.13: Relative influence of Lesotho Grade R Teachers' science content knowledge on their TOCPs

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T	Sig.	Collinearity Statistics Tolerance	VIF
(Constant)	-80.750	116.955		-.690	.492		
TPCCKSC	1.224	1.239	.110	.988	.326	.840	1.191
TPSCKFS	3.508	2.186	.164	1.604	.112	.999	1.001
TPHCK	-.916	2.065	-.050	-.443	.659	,839	1.191

a. Dependent Variable: Teacher-Oriented Classroom Practices (TOCP)

Table 4.13 above presents the relative influence of the predictor variables on TOCP. It shows that TPCCKSC (B= .110, t=.988, p>0.05), TPSCKFS (B= -.164, t= 1.604, p>0.05), and TPHCK (B= -.050, t=-.443, p>0.05) had no significant relative influence on TOCP. The p-values indicated in this table show that all the predictor variables have p-values higher than 0.05. They are *p* =.326, *p* = 112, *p* = .659 and are therefore not statistically significant. The non-significant relative influence of these predictors on TOCP, the tolerance and VIF values were normal. The spearman correlation analysis and a prior analysis arrive at the same conclusion that the teachers' knowledge seems to have weak or no influence on their classroom practice. This suggests a lack of systematic or deliberate connections between teachers' knowledge and classroom practice for this group of Grade R teachers in Lesotho.

In summary, the results from quantitative study briefly indicate the following:

- Table 4.3 indicates that the teachers seems to have the expected levels of CCK.
- The low aggregate mean score for tables 4.4 and 4.5 shows that teachers may have insufficient SCK.

- Table 4.6 shows that the teachers' HCK seems to be high although some teachers could not validate that.
- The results for both table 4.7 and 4.8 reflects that teachers use both teacher-oriented and learner-oriented classroom practices.
- The correlation analysis established that there is a weak correlation between TPCCKSC with LOCP and TOCP.
- TPSCKFS has both weak correlation with TOCP and LOCP.
- On the other hand, TPHCK has a weak correlation with TOCP but a moderate correlation with LOCP.
- The regression analysis confirmed that there is no auto correlation between TPCCKSC, TPSCKFS and TPHCK and the dependent variable LOCP.
- The regression analysis also confirmed that TPCCKSC, TPSCKFS and TPHCK predictors did not significantly influence TOCP.

In conclusion, the sampled Grade R teachers seem to have the expected CCK, but insufficient SCK with high levels of HCK. Correlation and regression analyses arrive at the same conclusion that the teachers' content knowledge in this case has weak or no influence on either learner or teacher-oriented classroom practices. In the next section, qualitative data is used to shine more light and to explain the findings of the quantitative analysis to verify the result of the first phase of the study.

4.6. Qualitative findings

This study follows an explanatory sequential design; consequently, quantitative results guided the commencement of the qualitative phase. I had to look at the results from the quantitative phase to guide me on what should be confirmed and explained. In doing so, the general picture of how Grade R teachers' science content knowledge shaped their classroom practices was organised around two themes influenced by the research questions, namely: (i) Science content knowledge of Grade R teachers and (ii) Teaching the selected science concepts. Semi-structured interviews, classroom observations and document analysis were used based on the aforementioned themes. The process of analysing qualitative research afforded me an opportunity to validate what teachers claimed they knew or did through classroom observations and their lesson plans.

Issues of ethical considerations were well thought out while working with the participants, including the use of pseudonyms to protect their identities. Four teachers, given the names Mrs Raiso, Mrs Haiso, Mrs Neuza and Mrs Khebs, were conveniently selected to participate in the qualitative data generation and their pseudonyms are used consistently throughout. The following themes were generated from the interviews, classroom observation protocol and document analyses:

1. Science Content Knowledge of Grade R teachers

2. Teaching the selected science concepts (floating and sinking)

Table 4.14: Summary of emerging themes, subthemes, and categories

Secondary research questions	Themes	Subthemes	Categories
Interviews, Observations and documents			
What is the science content knowledge of Grade R teachers' in Lesotho on selected science concepts?	4.6.1 Science Content Knowledge of Grade R teachers (on floating and sinking)	4.6.1.1Teachers' Common Content Knowledge (CCK)	4.6.1.1.1 Knowledge exposure
			4.6.1.1.2 Conceptualising floating and sinking
		4.6.1.2 Teachers' Specialised Content Knowledge (SCK)	4.6.1.2.1 Floating and sinking reasons
			4.6.1.2.2 Scientific skills
		4.6.1.3Teachers' Horizon Content Knowledge (HCK)	4.6.1.3.1 Progression
			4.6.1.3.2 Integration
Interviews, observations and documents			
How do Grade R teachers teach the selected science concepts to their learners?	4.6.2 Teaching the selected science concepts (floating and sinking)	4.6.2.1Teachers' approaches to teaching floating and sinking	4.6.2.1.1 Planning
			4.6.2.1.2 Presentation
			4.6.2.1.3 Learners' engagement
			4.6.2.1.4 Resources

4.7. Discussion on themes, subthemes and categories

A number of themes, sub-themes and categories that arose are examined in this section.

4.7.1. Science Content Knowledge of Grade R teachers

The theme "Science Content Knowledge of Grade R teachers" fitted appropriately as it was found to align with the research questions and therefore had the potential to elicit relevant information. This theme was divided into the following sub-themes: (i) Teachers' Common Content Knowledge, (ii) Teachers' Specialised Content Knowledge and (iii) Teachers' Horizon Content Knowledge, discussed as follows.

4.7.1.1. Teachers' common content knowledge

Common content knowledge (CCK) is expounded as the expected level of knowledge acquired by any person who went to school (Campton & Stephenson's, 2014). In order to explore teachers' CCK, this sub-theme is arranged into the following categories: (i) Knowledge exposure; and (ii) Conceptualising floating and sinking. These categories describe in detail how participants responded to the interview questions that required deeper understanding of their CK in response to the secondary research question that requested them to showcase how much CCK they possessed.

a) Knowledge exposure

Information about teachers' exposure to science knowledge was collected from the participants during the interviews. This had the purpose of establishing how their high school and/or the teacher training experience helped them to be competent in science concepts that would in turn help them to teach in their own classrooms. Their views are captured below:

> Mrs Raiso: *I did Biology in high school. These other ones* (referring to Chemistry and Physics) *I really did not do. I did them in secondary school as they were called combined sciences*.

Mrs Haiso: *What can I say? In science, we were doing… I can't remember, we were doing Human and Social Biology*.

Mrs Neuza: *I did Biology, Chemistry and Physics. Now when I realise, it's like eh, when it comes to Physics, some of the things, even today I can't remember them.*

Mrs Khebs: *I did Biology*.

The three teachers, Mrs Raiso, Mrs Haiso and Mrs Khebs confessed that they had not previously studied Physics or Chemistry. The exception was Mrs Neuza, who had studied Physics, as captured in her statement. It is interesting also to note that Mrs Haiso did Human and Social biology, which relates to animal and plant life only, though that could have led to some limited content knowledge in physical science concepts. Based on the interview data it is clear that teachers did study the combined sciences in secondary school, as reflected in the interviews. For instance, Mrs Raiso indicated that:

…I did them in secondary school as they were called combined sciences.

Therefore, little could be inferred from these teachers' responses as their high school content could mostly have been located in the Biology subject. In terms of how the limited high school science content helped them in relation to classroom practices, Mrs Raiso agreed that the content she knew had helped her to conduct science activities with learners:

Now we are doing a topic which is called "myself". We have a sub-theme called "taking care of myself" from the topic myself. In Biology, we know ah how our bodies are built and to live hygienic and good life. We know what things we should do. So, if I did not do Biology by that time, it would not be easy for me now to teach about hygienic life, so that has some impact.

Mrs Haiso ran short of explanations when required to relate what she had studied in high school to what she was currently teaching in the classroom. Furthermore, participants were asked to give their views regarding how college education had exposed them to science concepts. The following was captured in their discussions:

> Mrs Raiso: *We had enough exposure with the science we did at the college because we already had some information from high school, so added together with the one we got from high school, it helped us a lot in implementing it when teaching. It was of great help, it was good, and its impact is remarkable*.

> Mrs Haiso: *Yes, it helps me a lot because now I have forgotten most of the things we did in high school, especially the topics that I am teaching now I remember how we were given tips to teach learners about them.*

> Mrs Neuza: *Before I went to the college I just taught some things without doing the experiments. But when I came back I did the experiments and I can see that they are learning more easily when we are doing the experiments.*

Mrs Khebs agreed that the college education had exposed her to various concepts. I had to probe further to relate what she gained from the college to what she was currently teaching in the classroom:

> *I can make an introduction that includes questions, a question can be, "who has ever swum?" Then from the swimming I will relate floating and sinking because the learner will say I once swum in the swimming pool. Then, I will ask, "What happens when you swim?" The learner will say "I float on top of the water."*

It is evident from the views above that participants regarded their exposure from the college science essential in relating science concepts to what they wanted to teach. Three out of the four teachers acknowledged that they had studied Biology in high school, and therefore the science knowledge gained in college could be regarded as indispensable.

b) Conceptualising floating and sinking

Participants were asked questions on their knowledge of floating and sinking, in line with Jakobsen et al.'s (2013) view of teachers' CCK as surface knowledge that teachers mostly get while they are being trained. On being asked to explain their understanding of the concepts floating and sinking, all four participants explained them as something to do with weight:

Mrs Raiso: *When we talk of floating and sinking we are talking in a situation whereby we are looking at the things. Eh, their <u>heaviness</u> and <u>lightness</u>, maybe using water in order to find out whether the object will float when put in water depending on its weight. And what will happen with water by the time the object is immersed, and to observe whether water will be on the same level or it will rise.* [Emphasis mine]

Mrs Haiso: *Floating refers to the objects which are not sinking in water or I can say floating objects are the objects which are <u>light</u>*. [Emphasis mine]

Mrs Neuza: *Floating are the things that float in water, they float because of their <u>density</u>*. [Emphasis mine]

Mrs Khebs: *Floating and sinking is a science activity, it is to teach learners science, floating and sinking, so that they know things that float and sink*. *Floating objects are <u>light</u>.* [Emphasis mine]

I had to probe all the participants to clarify their knowledge of the meaning of the concepts "floating" and "sinking" further. Mrs Raiso responded:

> *Floating is when something does not go down mostly in our situation we can say in water because we use water as our theme. And watch if the object is going to float. I think floating is… floating is when the object does not go down the water. It will move on top of the water. That is floating. But*

> *sinking is when this object goes down. Maybe because of <u>its weight</u>. For example, if you take an empty bottle and you put it in water it will float but when something is put inside it and is closed tightly, it will sink. It will go down. So I think sinking is when an object goes down in a fluid*. [Emphasis mine]

Mrs Raiso explained floating as related to when objects are suspended on the surface above water. This corresponds with the definition of floating as explained in *Collins English Dictionary* (2014). Her understanding of the definition of floating and sinking was further explored in her class interactions with learners. The following examines the aspect of her lesson on floating and sinking.

Mrs Raiso's explanation of floating and sinking to the learners

In the morning of Tuesday 28 February 2019, Mrs Raiso was taking a class of 21 Grade R learners. They were arranged in groups of three which, according to her, were based on their learning abilities. The lesson started at 10:00 hours. After introducing the lesson to the learners and telling them that they were going to learn about floating and sinking, the following discussion ensued:

<u>Lesson segment 1</u>

Teacher: *Where do you suppose we are going to see floating and sinking objects?*

All: *In water*.

T: *Yes. It is where we are going to see the floating and sinking objects.* (She asked learners to clap their hands then took out a flash card on which was written "sinking" and showed it to the learners). *This word is sinking* (referring to the flash card and allowing learners to say after her several times "sinking"). *Now, listen. What do you think sinking is?* (She repeated this and gave learners a chance to answer).

Learner 1: *Sinking is when they get in the water* (replied the learner shyly).

T: What? (Excited) *Say it out. Say it out*.

L1: *Is when they get in the water*.

T: *She says sinking is when something gets in the water, and that something goes down down down. Clap hands for her*. (Learners clapped hands). *She is correct. When we talk of sinking (re bua ka ho teba) we are talking about sinking. Things go down down in the water (li ea tlase tlase ka metsing). That is sinking. For example, if you have taken something and you put it in the water it will go….* (Waited for the learners to complete the sentence).

All: … *down*.

T: *Where?*

All: *Down*.

The lesson continued with a discussion of what learners thought floating was. Learners said something would go up and down. She asked them where, to which the learners replied "in the water." Mrs Raiso congratulated the learners, saying that they were clever. She explained further that if something was put in water and did not go down the process was called "floating." She explained sinking as the process whereby objects would go down in the water, while floating was when objects stayed on top of the water.

From the lesson, I could deduce that Mrs Raiso's conception of floating and sinking was not quite accurate as she did not take account of density. Also, elements of teacher dominance were observable as she further explained what L1 said. The learner had not said that the object would go down but Mrs Raiso rounded-up L1's explanation by saying that it would. Following is the preview of Mrs Haiso's explanation of floating and sinking to the learners.

Mrs Haiso's preview of explanation of floating and sinking to the learners

I observed Mrs Haiso the same day as Mrs Raiso, as per our arrangement. Apparently, Mrs Haiso had introduced the lesson the day before the observation. Having learnt about this only during the interview with her after the lesson, I did not have a chance to see or hear her explaining to the learners the meaning of the words “float” and “sink”. However, I expected the teacher to remind the learners about the meaning of the concepts before giving them activities. From a chess class, learners sat at their tables ready for the lesson to start. The class started at 9:00 A.M. on 28 February 2019. Seated in a horseshoe formation, it was a class of 19 Grade R learners. At the beginning of the lesson the teacher gave learners material they would put in a prepared washbasin that was half-filled with water. She asked one group to gather around the activity corner and the lesson continued as follows:

<u>Lesson segment 2</u>

T: *We are going to see what happens when we put objects in water. Let’s start with a stone.* (She asked one learner to put the stone in water). *What is happening with the stone?*

L1: *Sinking*.

T: *The stone is* ...

All: *Sinking*.

T: *Why is it sinking?*

L2: *Because they* [sic] *are heavy.*

T: *Eh?*

All: *Because they* [sic] *are heavy*.

T: *Because they* [sic] *are heavy. Now let us put the leaves in water*. (One learner who took some leaves did so). *What is happening with the leaves?*

L3: *They are floating*.

T: *Why are they floating?*

L4: *Because they are light.*

The lesson progressed with the teacher asking learners to put different objects in the water and communicated what happened to them. Most of the answers learners gave were appropriate. Later, she explained to the learners that objects sank in water because they were heavier than water, but she did not explain what she meant by this. After the lesson, I inquired about this in the interview. The teacher explained that learners were used to holding objects with their hands so they knew when they were heavy or light. When I mentioned that I had not seen her asking learners to do that she insisted that one group had held the objects. As we were talking on that point, she claimed that it was because they differed in their abilities. However, the teacher could not relate to the necessity of comparing the two words for all her learners.

Since I did not observe Mrs Haiso on the first day when she was introducing the lesson to the learners she counted on the previous lesson to reflect contents relating to the concepts “floating” and “sinking,” which seemingly she did not find. I concluded that at worst, the teacher had not explained the concepts to the learners, or at the best, the learners were still unclear about the concepts.

I probed Mrs Haiso to explain what she meant by floating objects not sinking in water. She explained:

> *Floating refers to objects which do not sink in water. They are plastic, stick, leaves, according to their materials that made them, even if they are big or small, they are floating in water because they are light. Sinking refers to objects that sink in water because of their weight, even if they are small, they will sink because of the materials that made them. Sinking is the opposite of floating*. [Emphasis mine]

Mrs Neuza's explanation of floating and sinking to the learners

Mrs Neuza talked of her explanation of floating and sinking concepts in an interview with me: "*Floating are the things that float in water, they float because of their density"* [Emphasis mine].When probed, she said:

> *It is like when I put things in water and they are not sinking, they stay on top of the water, they do not stay underneath water. Because they are lighter than water. Sinking is when objects stay under the water, which happens because they are heavier than water*. [Emphasis mine]

Mrs Neuza's had a class of nine learners. She sat on a small chair in front of them as they were seated in a horseshoe formation on a mat. At the beginning of the lesson, she read a biblical story about Noah's ark to the learners. She asked them questions about the words "water" and the boat "floating." Based on the story, I had the feeling that she assumed learners were clear about why things floated or sank in water. The following is how she embarked on the lesson presentation:

Lesson segment 3

T: *Okay, in the story we heard that the boat was floating. Now, tell me, what are the other things that you think can float in water?* (She repeated the question.).

L1: *A bottle top*.

T: *You think a bottle top can float in water?* (She called another learner).

L2: *A stone*.

T: *Can the stone float?*

All: *No.*

T: *Okay, tell me, if you are swimming into the water, are you floating or are you sinking?* (She repeated).

L3: *You sink*.

T: *You sink! And if you are drowning, what is happening to you?*

L4: *You sinking.*

T: *And you are also sinking? But if you are swimming properly you will float. Okay, before we do the experiment, tell me why do you think the other objects will float and the other one will sink in water?*

Mrs Neuza hurried the guessing activity to ask learners why they thought objects floated and sank, as presented above. She had in my view, missed the opportunity to explain to the learners the concepts of floating and sinking, even by means of simple words.

Mrs Khebs's excerpt of explanation of floating and sinking to the learners

Mrs Khebs explained floating and sinking in our pre-observation interview after I probed her to explain what she meant by "science activity taught to learners":

> *We talk of things that are not under water, things that are on top of the water because of their <u>weight</u>, it can be <u>weight</u> or their make of materials. Sinking is also a science concept that we teach learners to know which things can sink and why things sink. Things that sink stay under the water.* [Emphasis mine]

She further explained that things would float on water because of their weight or the materials of which they are made.

Mrs Khebs, on the other hand, had a class of 24 Grade R learners, which were mixed together with preschool learners for the morning circle. They were gathered together on the mat engaged in some oral activities that included days of the week, months of the year, seasons of the year and rhymes. Pre-schoolers were then taken to another classroom. Her introduction began with asking learners if they had ever swum or seen a person swimming. Different answers from the learners included "in the river" and "on television." The discussion went as follows.

Lesson segment 4

T: (Asking a learner whose hand was up). *Ha ke re u re u kile oa sesa brother. Re joetse na ho etsuoa joang hobane nna ha ke tsebe. You did say you once swum brother. Tell us how it is done as for myself I do not know*.

L1: *Kea kolumela. I dive.*

T: *U kolumela joang? U sheba tlase. How do you dive? Do you go down?*

L1: *Yes teacher*.

T: *U kena ka metsing e be u ea tlase? Kapa u ba ka holima metsi*. *Do you get in the water and go down? Or do you stay on top of the water?*

L1: *Ke ba ka holima metsi*. *I stay on top of the water*.

T: (The teacher continued asking other learners to tell what happens when they swim or with the people they saw swimming). *Okay, le re motho ha sesa o ba ka holima metsi, lejoe lona? You say a person when she swims she stay on top of the water, what about the stone?*

All: *Lea teba*. *It sinks*.

T: *Le etsang lejoe ha le teba*? *What happens with the stone when it sinks?*

All: *Le ea tlase*. *It goes down*.

T: *Okay, ntho ha e phapamala ka metsing it is floating*. *Empa ha e teba it is sinking.When an object is on top of the water, it is floating. But when it goes below the surface of water, it is sinking*.

The lesson continued with the teacher showing the learners drawn pictures of objects that sank and floated in water. She asked learners to point to the one that was floating and the one that was sinking. In this case, I got the sense that the use of Sesotho mother tongue might have contributed to the clarity the learners displayed of the concepts.

Summary of the four teachers' lessons

All four teachers' explanations of floating and sinking and the way they presented them to the learners would most probably make sense outside an academic context, however, in my analysis, Mrs Neuza did not explain the concepts to the learners as explicitly as she had done in the pre-observation interview. Mrs Khebs' used learners' mother tongue throughout the lesson, which could have somehow have helped learners understand the concept better. In the post-interview with me, on how she felt with the delivery of the lesson she said she was surprised by the way learners understood the concepts. She stressed that she had not expected such a positive response as learners were able to give relevant information regarding floating and sinking.

4.7.1.2. Teachers' Specialised Content Knowledge

Specialised content knowledge (SCK) is clarified as the specific knowledge needed for teaching but which is not usually needed in other professions (Herbst & Kosko, 2012). Thus, it is the knowledge that is specific for teachers. To explore teachers' SCK, this theme is divided into the following categories: (i) Floating and sinking reasons and (ii) Scientific skills.

a) Floating or sinking reasons

I regard the knowledge of why objects float or sink in water as specialised knowledge that would be needed by a teacher who is well versed in the concepts. This aligns with the significance of SCK postulated by Zambak and Tyminski (2017), that SCK is a specialised subject matter that a teacher needs to develop, but not to use it to teach as in CCK. The teacher is expected to utilize his/her SCK to overcome possible problems with learners. I tapped on the participants' SCK by asking questions that required an explanation of what caused objects to float in water.

Mrs Raiso indicated that objects float because they are light, as did Mrs Haiso, who stated: "*Yes, except that they are light, I do not know*". Mrs Neuza and Mrs Khebs's explanations were scientifically valid as they mentioned that objects floated because their density was less than water. When asked what caused objects to float, Mrs Neuza said: "*It is because their density is less than water. It is not heavier than water; therefore, the object will not sink in water,*" while Mrs Khebs said: "*I think, the object will float in water because it is lighter than water.*" On being asked to clarify what she meant about objects being less dense than water, Mrs Neuza explained: "*The shape and the materials of the object determine whether the density of the object is less or mor*e." Realising that the participant might have some knowledge on why things floated I gave her a scenario to explain why objects made from the same material, such as a metal spoon and a ship, would sink and the other float. She maintained that it would be the material of which they were composed. I repeated to the participant that the materials that made the spoon and the ship are the same but that the spoon would still sink while the boat would float. She said "*Its front part looks like a triangle and underneath is oval like shape.*" She added that the shape of the ship contributed to the floating process. None of the four participants spoke about the fact that the volume of the ship made its density low and that was why it floated in water. For instance, Mrs Raiso said:

> *Let me answer that by myself, I do not have any… I think, It is made of some things like it has engine and the steering, so, there is someone who is always there driving. So, it will not sink it will go. But the spoon will sink because* …. (Laughing).

Mrs Khebs did not explain further than to say, "*And the ship is made of metal. And they are very big.*" This was an interesting attempt but not scientifically accurate.

My analysis of the four participants' knowledge showed that the teachers were struggling to articulate clearly why objects floated and sank in water, however two respondents, Mrs Neuza and Mrs Khebs, had a valid scientific explanation. I probed the participants in order to understand their views. Mrs Raiso stated that "*I think it is light, there is no pressure that will pull it down so that object rises up.*" Mrs Haiso's response was similar to that of Mrs Raiso. Although Mrs Neuza and Khebs claimed that objects floated because they were less dense, they knew neither about the forces that caused objects to float nor molecules or particles in objects that were less dense than water. The declaration for this is reflected in the following statement by Mrs Neuza: "*I have forgotten, when force of gravity happens and why it happens*." She confessed that she has forgotten about forces involved in floating objects, only remembering gravity.

The four teachers' SCK regarding why objects floated was not as extensive and thus could be described as partly surface. Even the two teachers, Mrs Neuza and Mrs Khebs, who had better ideas about objects floating because they were less dense than water, could not explain the concepts extensively. They mentioned neither the forces that cause objects to float nor the molecules in objects that were not sufficiently compact to cause them to sink.

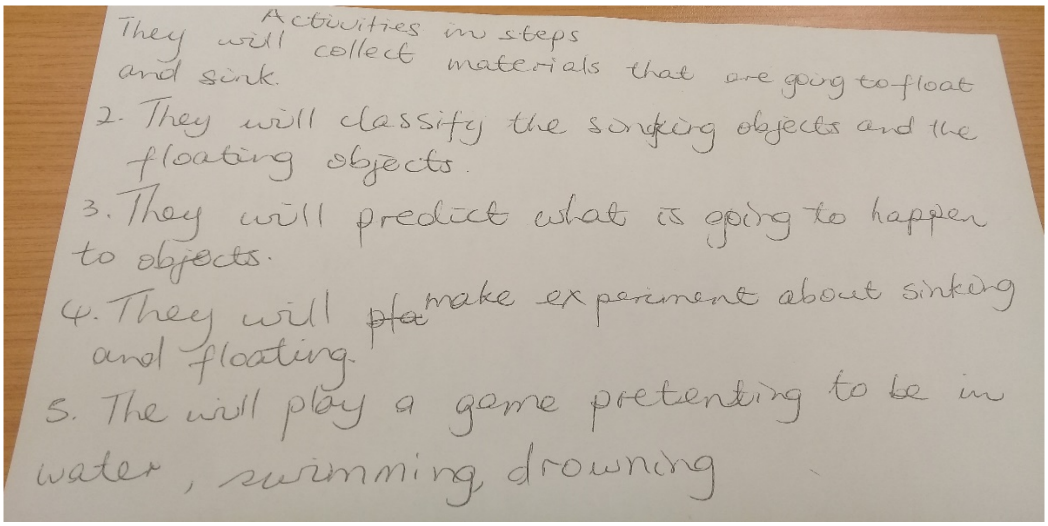
b) Scientific skills

Teachers' SCK is demonstrated when teachers allow learners to engage in scientific processes which will result in learners gaining the necessary scientific skills. When learners are given a chance to practise they develop scientific skills such as predicting, observing, experimenting, classifying, communicating, measuring and inferring. Due to their developmental ability, young learners might not know that they have certain skills, however, it might be expected that a knowledgeable teacher will help them to acquire those skills in order to prepare them for formal school. Therefore, this category sought to explore teachers' SCK in this regard. They were interviewed and their lesson activities analysed in order to unpack their SCK in catering for scientific skills.

Mrs Neuza mentioned only communication and experimentation skills in her interview, while Mrs Raiso only mentioned observation skill. Mrs Neuza said:

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.

Below is Mrs Neuza's lesson activities that show the scientific skills that she wished to engage with learners.



Activities in steps
They will collect materials that are going to float and sink.
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 ~~pla~~ make experiment about sinking and floating.
5. The will play a game pretenting to be in water, swimming, drowning

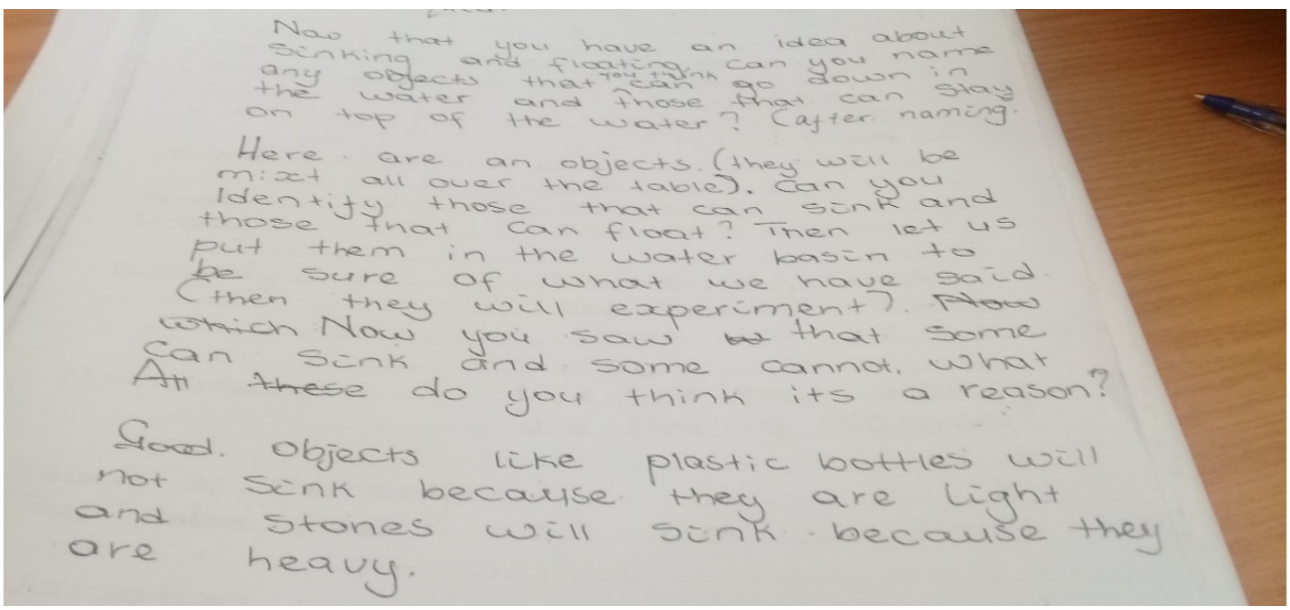
Figure 4.3: Mrs Neuza's lesson activities

In Mrs Neuza's planned lesson activities (above) she wrote that learners would classify, predict, and experiment. However, the scientific skills she mentioned during the interview were communication, observation and experimentation. I therefore expected the teacher to ask learners to talk about floating and sinking objects and to observe what happened with those objects as she indicated that she would do in the pre-teaching interview. Excluding them from the lesson activities compelled me to conclude that thinking about what to do and embarking on the activity might be slightly different. It was not clear why Mrs Neuza did not include the skills she said she would develop. Nonetheless, the activities were clearly carried out during lesson presentation, in part because the teacher referred to her planning repeatedly.

Mrs Raiso needed more probing for her to understand my question that required her to explain the scientific skills she planned to focus on during the lesson. When probed, she explained:

> *Oh, they will be observing, right! Then when we are done with their activities, we sit down and discuss about… Even before that while doing the activities, we discuss and ask one another some questions on which ones float and which ones sink, why do we think they float or sink. Then we sit down to check whether they understood or not, whether they really observed, we will ask questions on what we have just done.*

Below is Mrs Raiso's lesson activities that show the scientific skills she planned to cover:



Now that you have an idea about Sinking and floating, can you name any objects that you think can go down in the water and those that can stay on top of the water? (after naming.

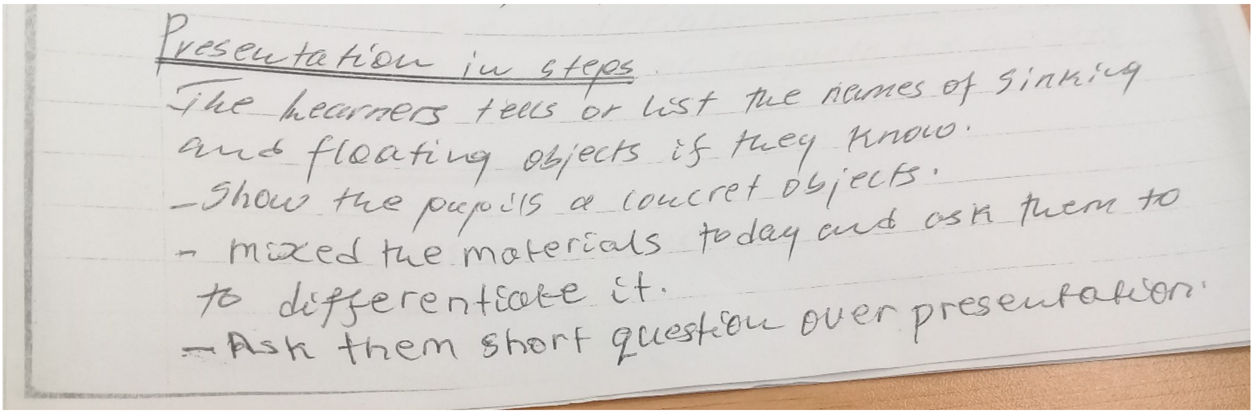
Here are an objects. (they will be mixt all over the table). Can you Identify those that can sink and those that can float? Then let us put them in the water basin to be sure of what we have said (then they will experiment). ~~How~~ ~~which~~ Now you saw ~~be~~ that some can sink and some cannot. What ~~All~~ ~~these~~ do you think its a reason?

Good. Objects like plastic bottles will not sink because they are light and stones will sink because they are heavy.

Figure 4.4: Mrs Raiso's lesson activities

Mrs Raiso's planning prominently shows experimenting as one activity that would be practised by the learners. One can deduce that there is prediction as learners were given a chance to identify objects that can sink and float from the given objects. During my pre-observation interview, Mrs Raiso mentioned thatlearners would observe whether objects floated or sank but I did not see this reflected in her lesson plan.

Of the four participants, Mrs Haiso and Mrs Khebs appeared confused when asked about the scientific skills learners would develop in their lessons. For example, Mrs Haiso could not say the scientific skills learners were to develop: "*The skill that they will have will be…. Eh*" (Murmuring, she did not come up with the answer).



Presentation in steps.
The learners tells or list the names of sinking and floating objects if they know.
-Show the pupils a concret objects.
- mixed the materials today and ask them to to differentiate it.
-Ask them short question over presentation.

Figure 4.5: Mrs Haiso's lesson activities

Mrs Haiso's lesson presentation in Figure 4.5 above does not show scientific skills that are targeted for the young learners. This helps explain why she could not provide an answer when asked about the scientific skills she wanted to develop in learners. Only the first activity was related to floating and sinking as learners were expected to list the floating and sinking objects they knew. The other activities neither helped nor guided learners to achieve the stated objective, which read: "At the end of the lesson learners should be able to identify the sinking and floating objects". The focus of Mrs Haiso's lesson was on learners identifying floating and sinking objects, however, it was not specific on how learners would do that. Rather, she planned to ask them to tell the names of the floating and sinking objects, show, mix and ask them to differentiate between the materials. This suggest that Mrs Haiso's planning did not help learners to achieve the stated objective.

In relation to the scientific skills learners would develop, Mrs Khebs said: "*I think it will be why things float and why some things will sink. The other one will sink because of its weight or the material it was made of, like metal.*"

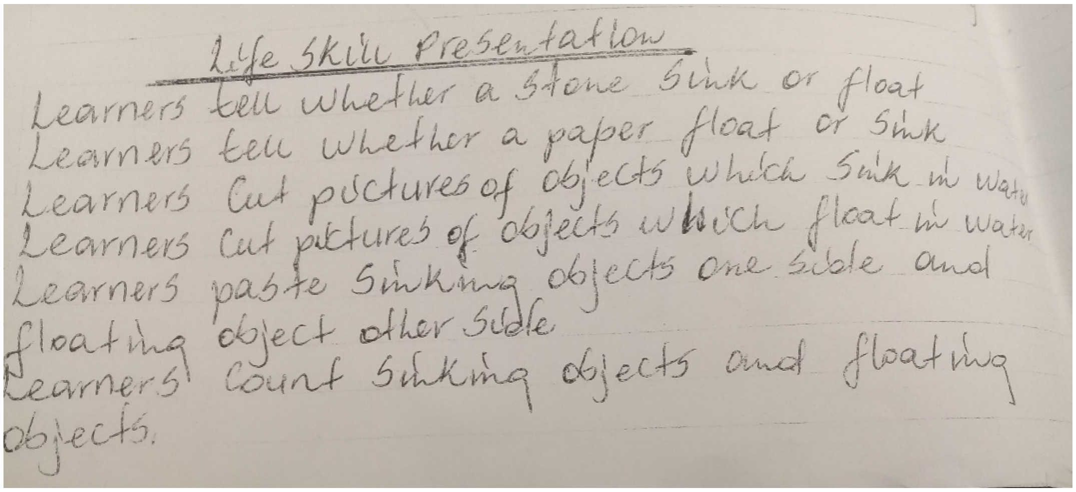

Life Skill Presentation
Learners tell whether a stone sink or float
Learners tell whether a paper float or sink
Learners cut pictures of objects which sink in water
Learners cut pictures of objects which float in water
Learners paste sinking objects one side and floating object other side
Learners count sinking objects and floating objects.

Figure 4.6: Mrs Khebs's lesson activities

Analysis of the above lesson activities shows that the lesson would be participatory. Although not evidently shown, learners were to be given a chance to record the floating and sinking objects by cutting and pasting them on the chart. Mrs Khebs did not mention recording as one of the scientific skills in our discussion but she did indicate it in her planning.

Data from all the teachers indicates that only Mrs Neuza's lesson plan activities showed clearly the scientific skills learners were expected to acquire. The other teachers' activities were rather vague and some did not align with their objectives. Planning and incorporating the necessary scientific skills seemed to be a challenge for the teachers.

4.7.2.3. Teachers' Horizon Content Knowledge

Jacobsen et al. (2013) relate horizon content knowledge (HCK) to vigilance of connecting related topics across the subjects included in the curriculum. In other words, Grade R teachers would be aware of the content that learners would cover in higher grades. These authors also show that teachers would know connections between concepts to be developed later for the benefit of the learners, due to their basic school learning experience. Teachers' HCK was uncovered from the participants during the interviews with the purpose of answering the research question: What is the science content knowledge of Grade R teachers in Lesotho on selected science concepts? This subtheme is divided into the following categories: (i) Progression and (ii) Integration.

a) Progression

In the exit interview, I asked teachers how they could relate concepts that learners would learn when they move to the upper grades. The participants gave different responses. Mrs Raiso and Mrs Khebs agreed on the concept of forces. Mrs Raiso also agreed with Mrs Neuza that learners would have to learn about density, saying: "*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*."

Mrs Khebs was also determined that learners would have to learn the concepts related to force: "*I think they will learn about force, if I remember correctly*." Mrs Khebs's response was consistent with the subject matter, though her qualification, "*if I remember correctly*," suggests that she was asking for my approval. Mrs Neuza expected learners to learn about density when they reached the upper grades. She said: "*I expect them to learn about density that some things even if they are small, their density can be larger than water.*"

Both Mrs Raiso and Mrs Neuza were emphatic that learners would have to learn about density when they reached the upper grades. During the second classroom observation, Mrs Neuza told learners that objects floated or sank due to their density. I asked whether she felt it was alright to talk about density to Grade R learners and she replied that "density" might be difficult for the learners to conceptualise but she was used to giving them vocabulary necessary for their learning.

When asked to clarify the concepts learners would encounter in upper grades that were related to floating and sinking, Mrs Haiso replied: "*I think they should go on with another method*." Her response was irrelevant to the question, therefore I probed further, but she laughed and said that she did not know.

Mrs Raiso, Mrs Neuza and Mrs Khebs were able to connect content related to floating and sinking. Mrs Khebs and Mrs Raiso revealed that learners would learn about forces while Mrs Raiso and Mrs Neuza mentioned density. Although not all the participants seemed to connect concepts across curricula, a number of them did. This indicates that teachers had HCK because they were able to connect concepts that would be developed later for the benefit of the learners based on their basic school learning experience, as proposed by Fernández and Figueiras (2014). One teacher could not connect floating and sinking to any of the concepts covered in upper grades.

b) Integration

The data suggests that the participants knew that concepts were integrated across curricula when teaching a certain topic or concept. For instance, all stated the learning areas that could be integrated with the intention of emphasising the concepts of floating and sinking when teaching. However, it is significant that their interview responses were different from their lesson plans. A further analysis of the lesson presentations suggested the same. When asked to relate how she could integrate floating and sinking in other learning areas, Mrs Raiso said:

> *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 in stick, stone and other objects*.

Even though Mrs Raiso said she could talk about objects in numeracy and dominant sound in literacy, her lesson activity did not reflect this (see Figure 4.4). However, her actual lesson presentation showed incorporation of counting and addition of numbers on floating and sinking objects. The incorporation is reproduced in the lesson segment below.

<u>Lesson segment 5</u>

T: *Group one, you are going to count how many objects are on the water surface, the objects that are light, the objects that are light. You are going to count how many they are. Those ones that did not sink. You are going to count how many they are. Okay?*

Group 1: *Yes teacher.*

T: *You just stand there, like this* (showing learners how they are going to count), *and then count, Alright? And then you sit down. You will tell us when you are back at your seats.*

Group 1: (Learners counted the objects and returned to their seats).

T: *Have you finished?*

Group 1: *Yes*.

T: *Okay, go and sit down. How many are they?*

Group 1: *Three.*

T: *How many are they?*

Group 1: *Three.*

T: *They are three. The objects that did not sink are three. Which are…. Name them. Name them,* (she called one learner who was playing).

L1: *The box.*

The lesson continued with learners calling the names of the floating objects. Group 2 was selected to go to the activity corner to count the sinking objects. They counted them and gave the numbers thereafter. Group 3 was chosen to add the floating and sinking objects together.

I observed that Mrs Haiso‘s lesson activities did not indicate counting of objects as she mentioned she would do in the pre-teaching interview (see Figure 4.5). When asked how she would integrate floating and sinking concepts with other learning areas she answered: “*In numeracy, we can count how many objects are floating and how many objects are sinking. In Literacy, we can give the names of the* *objects.*" Of the five lesson presentations by Mrs Haiso, integration of other learning areas with the purpose of emphasising floating and sinking content was not included. This suggests that the participant did know how the integration of content across curricula could be facilitated, even though this was not shown in her planning or lesson presentations.

Mrs Neuza also acknowledged knowledge of emphasising floating and sinking concepts in other learning areas:

> *In numeracy, if we are talking about the balloon, a balloon is another shape. We will talk about the names of the shapes that we used like triangle. Even the colours we will talk about them. In literacy, we can stress the sounds of the objects and do picture reading*.

Although Mrs Neuza said she could talk about the shape of the objects and their colours, I also noticed that it did not happen during her lesson presentation. Looking at Figure 4.3 of her lesson activities, there was no indication of integration of subjects across curricula.

Mrs Khebs' explanation of how she could include other learning areas to emphasise floating and sinking was based on activity corners as learning areas:

> *At the fantasy, we can play with water, put some bottles in water and see the ones that float and sink. At the Art corner we can draw the objects that sink or float or colour them. We can do drawing and colouring in Art corner. At the book corner, they can page through the books and see the objects that are floating or sinking. We can do other activities outside, like building small dam and put some objects inside it to see if they float or sink.*

Mrs Khebs was the only participant who included an activity that directly addressed other learning areas. As shown in Figure 4.6, although she was able to integrate the concepts of floating and sinking with other learning areas, she did not mention it in our pre-teaching interview. Instead, she talked about what she could do in activity corners, which I regarded as knowledge of integrating concepts across curricula. In an interview after teaching, Mrs Khebs revealed that she searched for activities she would take from the Internet. Again, she was the only participant who made reference to the Internet to expand her knowledge of science activities, and this as clearly evident in her teaching. She applied the progressive and activity-centred approaches that is often recommended for science teaching (Lazonder & Harmsen, 2016).

When analysing the four participants' ways of teaching, for instance planning, I realised that it differed sometimes from their actual lesson presentations. Various factors might have influenced this. For example, teachers might have consulted other teachers after an interview on what they could include in the teaching of the science content. This information was clear from their responses on the sources of their information. Mrs Khebs said she took information from the Internet, while Mrs Haiso and Mrs Raiso stated that they consulted other teachers.

4.7.2. Teaching the selected science concepts (floating and sinking)

An in-depth analysis of classroom observations and teachers' lesson plans helped to shed light on how Grade R teachers taught selected science concepts of floating and sinking. Therefore, for this section, participants' views on how they taught, classroom observations and their lesson plans are evaluated. Their lesson objectives, activities, assessment and conclusions were analysed in line with what they said they did in the classrooms and what they actually did. As a result, cross-reference checks, known as triangulation, considered responses gained during interviews and classroom observations. Mrs Raiso, for instance, produced one lesson plan that she claimed to use for a week. Mrs Haiso gave out two lesson plans during the five times that she was observed. Mrs Neuza also gave out two lesson plans that were used in the two lessons in which she was observed. I analysed one lesson for I considered that they had same structure in differed in objectives, activities, assessment and conclusion. Mrs Khebs produced four lesson plans during the time she was observed. Her second lesson was used for analysis, considering that her lessons had similar structures and were only different in objectives.

The teachers' lesson plans were analysed first before they could start teaching learners. The purpose of doing so was to understand what to observe as well as what the teacher would deliver in terms of content. I analysed all the components of the lesson plan, including date, duration, class size, objective(s), teaching methods and materials, introduction, lesson activities, assessment and conclusion. However, much attention was given to the objectives, activities, teaching methods, assessment and conclusion as deemed crucial in the design and implementation of lesson plans to measure learning (Ghanaguru et al., 2017). The analysis of the teachers' interviews, lesson plans, and classroom observations gave a sense of how they taught the selected science concepts.

The following section explains how teachers planned and presented their lessons, engaged learners and used resources.

4.7.2.1. Planning

a) Lesson objective(s)

Objectives guide a lesson plan and how it unfolds in the teaching and learning situation. Hence, I analysed the four participants' lesson objectives. Data shows that Mrs Raiso, Mrs Haiso and Mrs Khebs planned to have learners identify sinking and floating objects, as can be seen in the excerpts of objectives below. It was only Mrs Neuza (Figure 4.9) who asked learners to mention objects that floated and sank in water.

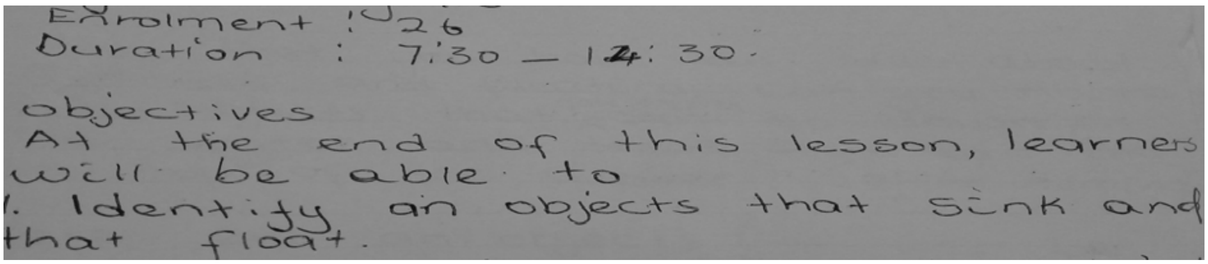

Enrolment : 26
Duration : 7:30 — 12:30.
objectives
At the end of this lesson, learners will be able to
1. Identify an objects that sink and that float.

Figure 4.7: Mrs Raiso's lesson objective

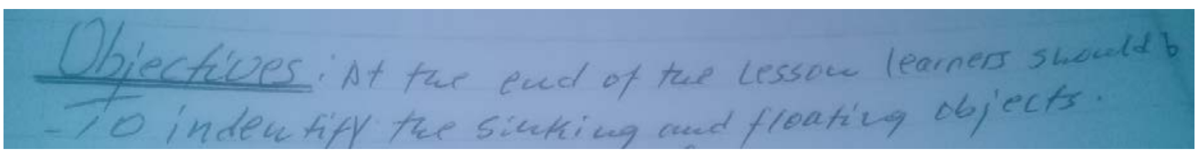

Objectives: At the end of the lesson learners should b
-To indentify the sinking and floating objects.

Figure 4.8: Mrs Haiso's lesson objective

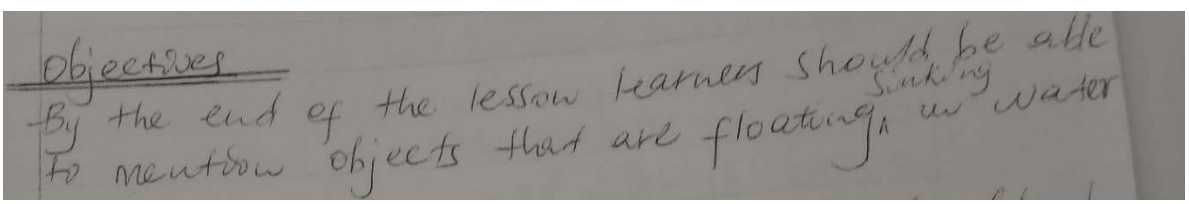

Objectives
By the end of the lesson learners should be able
To mention objects that are floating sinking in water

Figure 4.9: Mrs Neuza's lesson objective

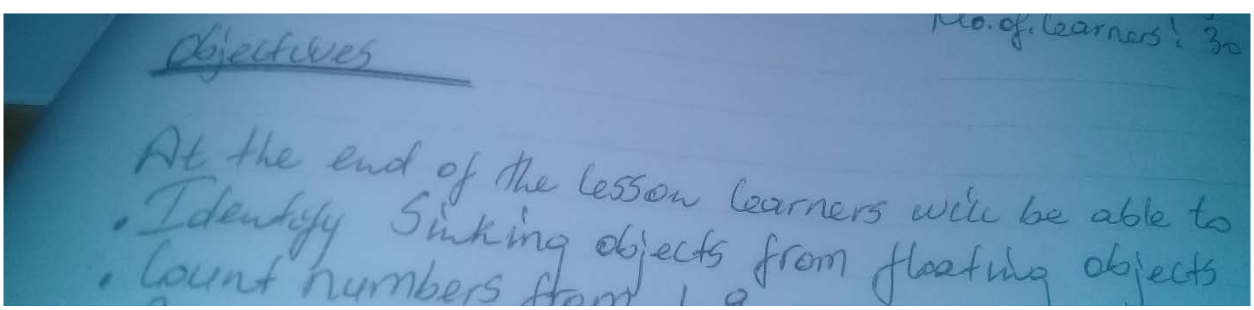

Objectives
No. of learners: 30
At the end of the lesson learners will be able to
• Identify Sinking objects from floating objects
• Count numbers from 1

Figure 4.10: Mrs Kheb's lesson objective

Mrs Raiso's and Mrs Haiso's formulation of the objective did not necessarily demonstrate the features of a lesson objective, that it should be specific, measurable, achievable, realistic and time-bound (Johnson et al., 2011). The LCE (2019:15), Teaching Practice Guidelines used by the teachers in training, state that an outstanding lesson should be clear, logical, sequential and developed appropriately. On the contrary, these participants' objectives were broad, with elements of teachers' objectives not addressing their instruction, as observed by Barendsen and Henze (2019). A broad objective does not tell how learners will identify the object or how many objects will be there by making the whole lesson unrealistic and not achievable.

b) Teaching methods

Below is an excerpt of the participants' teaching methods derived from their lesson plans. Mrs Raiso's lesson plan did not specify any teaching methods, thus it does not appear in the excerpts below.

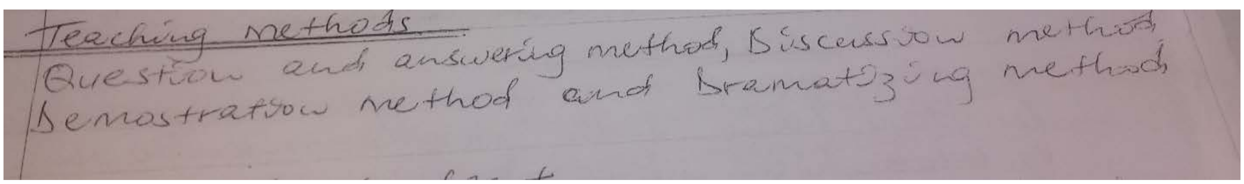

Teaching methods.
Question and answering method, Discussion method
Demostration method and Dramatizing method

Figure 4.11: Mrs Neuza's teaching methods

Out of interest, during a post-observation interview, I asked Mrs Neuza why she wrote "dramatizing" under the teaching methods, yet not use it in her teaching. She answered, "*I would ask them to do that in their structured play, but you won't be able to see that because they will do that after break in their fantasy corner.*" Knowing that there was such a time set aside, I was content with the response.

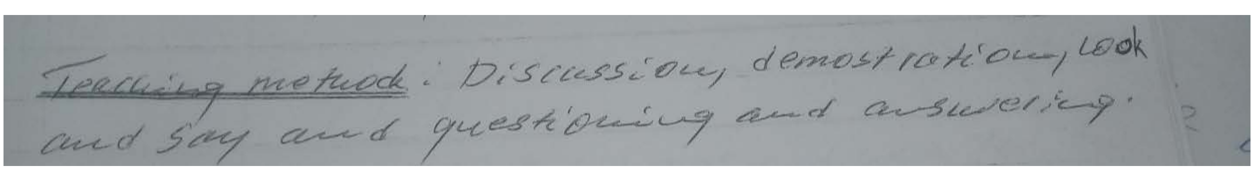

Teaching method: Discussion, demostration, look
and say and questioning and answering.

Figure 4.12: Mrs Haiso's teaching methods

The methods that were used by Mrs Haiso were those commonly used by the other teachers, as can be seen in their respective excerpts.

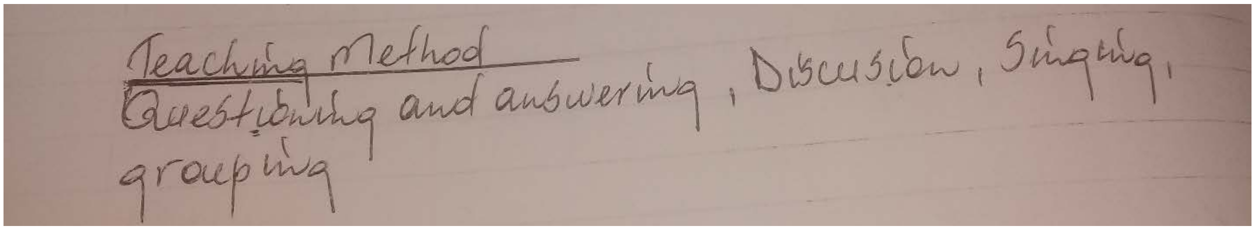


Figure 4.13: Mrs Khebs' teaching methods

Singing was listed by Mrs Khebs as one of the techniques she would use when teaching the concepts of floating and sinking. She had planned to use it to teach the learners but she confessed that she could not, primarily because she took too long with the group activity.

The data suggested that "questioning and answering," "discussing" and "demonstrating" were used more often by the teachers. Dramatizing and grouping were considered by Mrs Neuza and Mrs Khebs, respectively. Although the latter mentioned engaging methods, such as dramatizing and singing, which could have been exciting with young learners, none of the methods were actually used during the observations. "Discussing", "questioning and answering" methods were actually observed during teaching and learning, as can be seen through lesson segments outlined in this chapter.

c) Assessment and conclusions

Again, looking at Mrs Raiso's conclusion, it was not clear how or where she wrapped up her lesson by giving learners objects that sank or floated in water. Instead, the participant gave learners additional information that objects such as plastic bottles did not sink because they were light, while objects such as stones sank because they were heavy. The information that "objects did not sink because they are light" was thus not sufficient as she was also supposed to explain that it was due to the density of objects compared to the density of water. Below is Mrs Raiso's concluding extract.

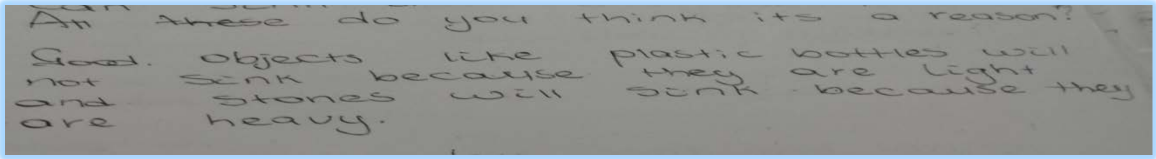
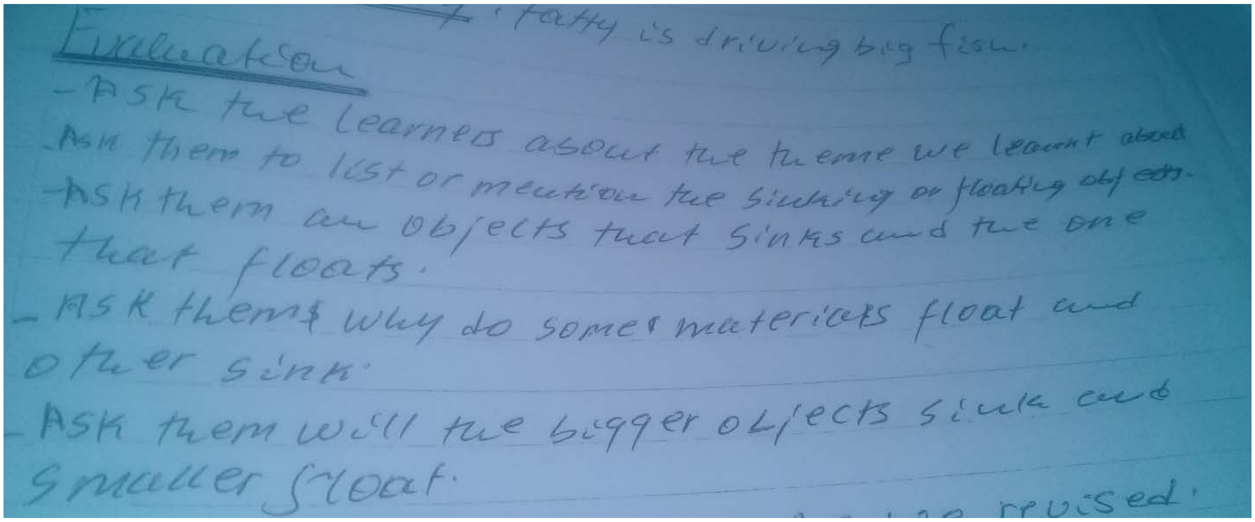


Figure 4.14: An extract of Mrs Raiso's lesson conclusion

The extract above shows Mrs Raiso's lesson conclusion on the concepts floating and sinking. It shows that the teacher did not conclude what she had planned to do in her lesson objective, namely, "learners will be able to identify an object that sink and that float." However, her conclusion was that "plastic bottles will not sink because they are light and stones will sink because they are heavy." It is true that the plastic bottle will float and the stone will sink, however, the reason given by Mrs Raiso was rather misleading to the learners as it is not lightness or heaviness that ultimately determine whether objects float or sink.

Although Mrs Raiso did not have a written lesson assessment I was able to record the following as her assessment. While she was teaching she asked learners to make a large circle around the activity table. She reminded them about the meaning of the concepts "float and sink," and said to the learners: "*Look at this*" (showing them the drawn table on the board), and "*this is our record of work.*" She then gave them the instruction that they should put the objects in the basin, and if the objects sank they should make a tick by using a piece of chalk in the drawn box on the chalkboard. She emphasised the opening letter "f" for floating and "s" for sinking. Learners were guided by the first letter. Mrs Raiso assessed across the curricula as emphasis on letters of the alphabet was made. In conclusion, she told learners that objects sank because they were heavy and floated because they were light, as discussed above.

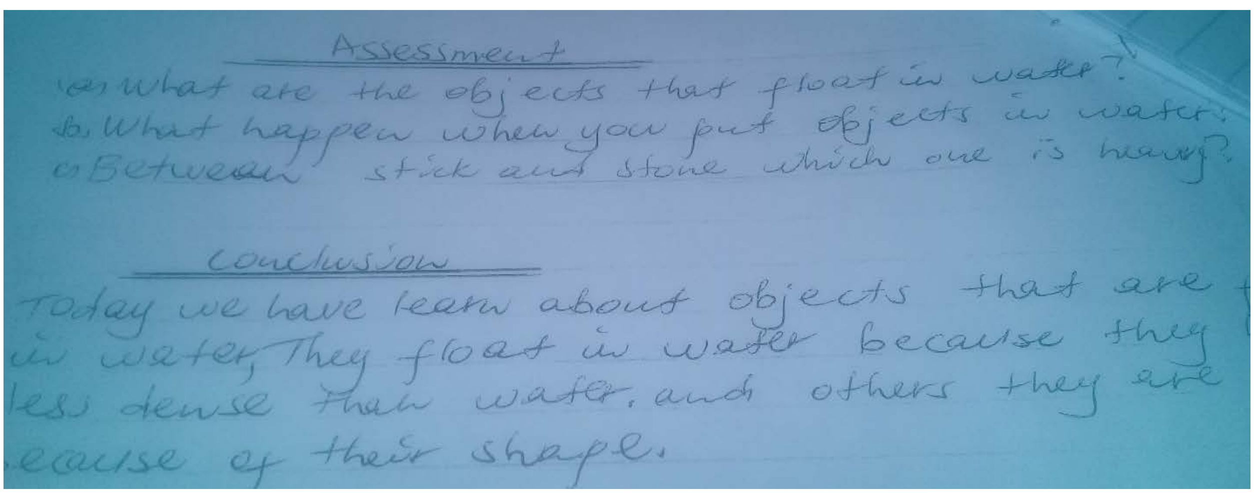
Below is Mrs Haiso's assessment, which she referred to as "evaluation."



Evaluation
- Ask the learners about the theme we learnt about
- Ask them to list or mention the sinking or floating objects.
- Ask them an objects that sinks and the one that floats.
- Ask them why do some materials float and other sink.
- Ask them will the bigger objects sink and smaller float.

Figure 4.15: Mrs Haiso’s lesson assessment

As with Mrs Raiso’s planning, Mrs Haiso’s lesson objective required learners to identify the floating and sinking objects. The same pattern of assessing what was actually not planned appeared in Mrs Haiso’s written evaluation, as reflected in the excerpts above.



Assessment

a. What are the objects that float in water?
b. What happen when you put objects in water?
c. Between stick and stone which one is heavy?

Conclusion

Today we have learn about objects that are in water, They float in water because they less dense than water, and others they are ecause of their shape.

Figure 4.16: Mrs Neuza’s lesson assessment and conclusion

Data shows that the assessed lesson and objective for Mrs Neuza did correspond. The planned objective and assessment in (a) above match. However, the conclusion deviates slightly from those, and therefore there is no alignment with the rest. The participant included the part that answered the question on why objects float, which calls for caution in the quest to establish the teachers' content knowledge.

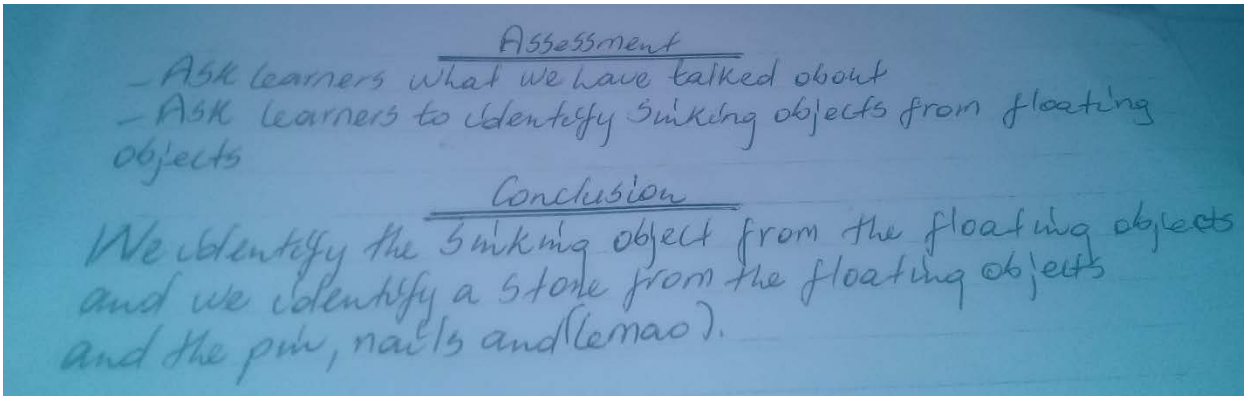


Figure 4.17: Mrs Khebs' lesson assessment and conclusion

Mrs Khebs' objective aligned well with the assessment and conclusion as she asked learners to identify sinking and floating objects. Her second bullet under assessment, in Figure 4.17, asked learners to identify sinking objects from floating objects. She concluded on the same note by emphasising that learners identified sinking objects from floating ones, which matches well with her planned objective. The next section explains how participants presented their lessons to the learners.

4.7.2.2. Presentation

I consider the methods and techniques for carrying out instruction as the core of the lesson presentation. How teachers' content knowledge influences practice can be located within the teaching strategies and activities engaged by the teacher. Hence, I used the following interview question to explore answers to the research question 2: "What activities do you do to achieve your planned objectives?" It became evident during the interview with Mrs Raiso that she engaged group work when teaching floating and sinking. She considered materials and wanted to teach learners the scientific skills, such as observation:

> *I will divide them into two groups. The other group will be in the class and the rest will be outside. And in the class we will have floating and sinking materials and that big washbasin, so that they do that activity, they put the*

> *materials and observe which ones will float and which ones will sink. And those outside will keep on playing with water and soil. They will mix it and make dough as they are doing that they will observe whether that soil will remain floating or sinking in water.*

The stated intention: "*I will divide them into two groups*," when read in context of the narrative above, suggests that Mrs Raiso planned to use group work to help learners understand the concept "float and sink." She even mentioned how the groups would operate. Her plan was that one group would be in the classroom while another would be outside. The question remained as to how the teacher would ensure that learning was maintained in those two separated groups. When asked how she would handle the two groups simultaneously, Mrs Raiso explained: "*We have two streams in this school, so I will ask another teacher to check them*." However, I observed that this lesson presentation was not carried out in the way it was described by the teacher.

Other activities, such as observing the objects that would float and sink, as mentioned in Mrs Raiso's interview, were relevant. Her last statement might be a sign of insufficient content knowledge. She said: "*They will mix it and make dough as they are doing that they will observe whether that soil will remain floating or sinking in water*." Making play dough is one claim and observing whether the soil will "remain floating or sinking" is another. The teacher linked two activities which were unrelated in that she treated "making play dough" and "observing whether that soil will remain floating or sinking in water" as one. The two activities cover two different scientific ideas and/or skills.

I examined Mrs Raiso's lesson activities to see if elements of group work were mentioned in her planning. Figure 4.4 shows how she planned her activities. Data shows that there was no mention of group activities in her planning. Although I had expected her to indicate how the groups would learn about floating and sinking, nothing was said in the plan about it. Rather, she asked learners to name the objects that could float and sink in water. She further asked them to put the objects in water while, in her planning; she had written that learners would be experimenting. Mrs Raiso's lesson activities included asking learners why some objects would sink while others would float.

The above discussions indicates some contradictions in what Mrs Raiso said she would do in the classroom when teaching the concept of floating and sinking with what she actually did and planned. The contradiction is evident in the planned classroom activities reproduced in Figure 4.4. Besides group activities, the scientific skill that she planned to develop in learners was different from the scientific skill that she said she would do to guide the learners. Other than listening to what the participant said she would do and planned to do, I also observed her lesson presentation with a focus on how she carried out the activities.

The classroom activities that were engaged in included showing the whole class two flash cards written "floating" and "sinking." She said "*this is sinking,*" showing learners the flash card, and "*this word is sinking,*" and allowed them to repeat the word "sinking" after her several times. She asked learners to explain what they thought "sinking" meant. After the learners responded, she gave an overview of what sinking meant. The same activity and discussion happened with "floating." The teacher assessed the activity by asking learners to tell what sinking and floating meant.

The next activity emanated from the arranged material that Mrs Raiso put in front of the class. She asked learners the names of the materials and, as she was doing that, emphasised plurality of words as she had many materials of a similar nature. She asked learners to come in front, one by one, to pick up the objects and put them under either the "floating" or "sinking" section. For example, she said to one learner: "*Khotso* (pseudonym) *come and show us which object will sink in water*." Khotso picked up the sinking object and returned to his seat. The next learner was called and the activity was repeated for many learners as they were asked to classify the objects. As learners picked up the objects, the teacher reminded them what floating objects did compared to sinking objects. One learner hesitantly picked the feather and said it would sink. She asked other learners whether they thought the feather would go down. Learners did not agree, so as a follow up she asked them why they disagreed. Learners replied "*because it is not heavy,*" giving the impression that they had acquired this from the lesson.

Showing the whole class flash cards, arranging the materials for the learners and asking them one by one to pick up the floating and sinking objects shows that Mrs Raiso was using the whole class activity and perhaps not the group activity, as she claimed during the pre-observation interview. The call, "*come and show us*" in the above paragraph, also shows that the teacher's presentation was expository in a way that the teacher was completely in charge and guiding the lesson. She was also in charge of the discussion and asked questions by calling on learners for answers, almost denying them a chance to work as a team. She might have been focusing on the skills of solving problems and communication (Novilia et al., 2017). Taking into account that Mrs Raiso said she would use group work, neither her lesson plan nor lesson presentation reflected that.

Data show that Mrs Raiso may have had too many activities for the learners, evidence of which was the 45 minutes lesson duration she used instead of a normal 30 minutes, trying to "squeeze" all the activities that came into her mind because most were not included in her lesson plan. When asked if she had an updated lesson plan she answered that: "*In this school we plan for the week, so we just write one lesson per week*." On the basis of this, I had to use the single lesson given by the participant.

In the same vein, Mrs Haiso was also asked the question on the activities in which she engaged to teach floating and sinking. Her response indicated that she would give learners some materials to distinguish between heavy and light. Apparently, Mrs Haiso taught the concept of floating and sinking the day before I came to observe her:

> *Yes, like I have said. They were working in groups, one would take stone out of the water and drop it, and again another would take a leaf and drop*

it in water and see what happens. They will see the difference that these ones sink in water and those ones float in water.

The above quote shows that the participant used group work in her lesson. However, her use of "one" in her narrative could mean "one learner" and not "one group," as she did not elaborate.

Analysis of Mrs Haiso's two lesson plans revealed that group work was actually not mentioned, contrary to what she had said earlier. This can be seen in Figure 4.3. The following extract shows the activities the participant planned for the second lesson.

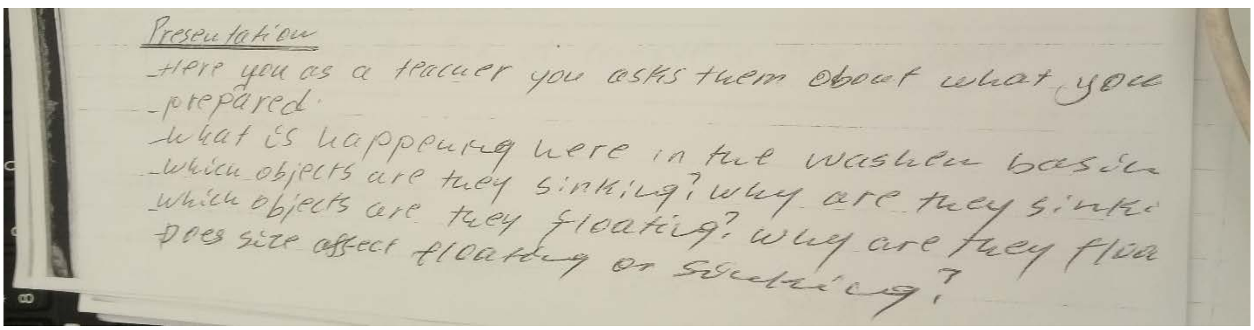

Presentation
- Here you as a teacuer you asks them about what you
- prepared.
- what is happening here in the washen basin
- which objects are they sinking? why are they sinki
- which objects are they floating? why are they floa
Does size affect floating or sinking?

Figure 4.18: Extract of Mrs Haiso's activities for the second lesson

The above extract does not indicate the use of group work, which Mrs Haiso claimed to have used. Nor was it reflected in the two lesson activities she produced, contradicting her claims and the lesson. She displayed a classroom practice which was consistent with most of the teachers' professed views about how they taught science, a finding generally consistent with Brickhouse's (1990) fining that teachers often claim to do one thing but write the opposite in their planning.

Another claim in Mrs Haiso's narratives, "*and see what happens,*" suggests that learners were going to "*observe*." Having observed what happens with the objects she anticipated that learners would "*see the difference*." In this context, it suggests observing the objects that would float and those that would sink. Engaging the scientific skills in the way the participant was doing shows that she knew that when learning science concepts, skills such as observation were necessary for young learners to further develop their curiosity. Her identification of the scientific skills shows that Mrs Haiso knew that to acquire certain knowledge of concepts, such as floating and sinking, some important scientific skills would have to be developed. However, knowledge of the scientific skills does not by itself imply that the teacher has sufficient content knowledge.

The data may demonstrate that Mrs Haiso's formulation of lesson activities was not as coherent. For instance, her bullets showed neither the beginning nor the end of an idea. Furthermore, her activities read more like notes than activities. The following statement given by the participant exemplifies this assertion: "*Here you as a teacher you asks* [sic] *them about what you prepared.*" That was followed by a series of questions that asked learners what was happening in the basin, which objects were sinking and which ones were floating and why. Her planned activities also asked a question on whether the size of the object made a difference.

Taking into account the group work in which she said she engaged, supposedly, the only time she did so was when she called learners by their groups to come to the front either to observe or put objects in water. Data demonstrate that, according to the participant, the activity translated into group work because in one of the post-observation interviews she said that she used group work to engage learners to show that a stone was heavy but a plastic spoon light. She explained: "*One group did that, I think it is the first group. Just that they have different learning abilities.*" Her response also demonstrated that she was not as attentive to which group had engaged in the activity.

As Mrs Haiso was teaching learners about the objects that floated and sank in water, she told them that the objects sink because they are heavier than water. She seemed to know that objects would float in water because they were lighter than water, but she did not mention anything about the particles spaces that made up the objects. That was revealed in the post-observation interview we had. She even explained to the learners that "*objects sink in water because the materials* *that made them are heavy,*" which was not actually accurate. It was evident from Mrs Haiso's declaration that she could not relate why some materials were heavy compared to water. Below is an example of an experiment the participant conducted with her learners.

Picture 4.1: Picture of an experiment conducted in Mrs Haiso's classroom

In another discussion, Mrs Neuza was also asked to explain the activities in which she would engage while teaching the concept of floating and sinking, to which she replied: "*We are going to do experiments*." When probed as to whether that was the only thing she was going to do she asked to refer to her lesson plan, however, I did not find it significant as her focus in the plan was on content knowledge. Before teaching the following day, I asked Mrs Neuza to share a sample of her lesson plan so that I could follow the lesson properly. Again, I wished to see whether it included the experimentation that she said she was going to engage in as part of the activities. The lesson plan showed that the experimentation was included, corroborating what she had told me during the interview session (see Figure 4.3). The participant's activities were clearly written and highlighted scientific skills such as classifying and predicting.

In the pre-observation interview, I discussed with Mrs Khebs, we discussed the activities that she planned to use for teaching the concepts of floating and sinking:

> *I will start by drawing the level of water, and draw the stone on the bottom. On the other one I will draw the pencil on top of the water. Then I will demonstrate to them the floating and sinking content. Then they will tell me that this one is sinking and this one is floating. Then we will work in groups, they will put the objects in water and decide whether they are sinking and floating*.

The above narrative suggests that she would come to class with two pictures of floating objects and sinking objects. With the help of the pictures the participant proposed to show the learners what she meant by floating and sinking. She also suggested that learners would work in groups to formulate predictions and draw conclusions as they observed.

Similarly, I explored Mrs Khebs' activities in the lesson plan. Since she mentioned that she would begin by showing learners pictures of floating and sinking objects, I referred to the section on materials, under which no pictures were drawn, but rather stones, papers, crayons, pencils, blocks, bottles and a washing basin mentioned as her written materials. Nor did she include demonstration as the teaching method or group work activity. She only reflected that learners would tell whether a stone or a paper was floating or sinking. The plan indicated that the teacher intended asking learners to cut out pictures of floating and sinking objects, then paste and count them. Nothing Mrs Khebs said she would do during the pre-observation interview was actually reflected in her lesson plan.

When dealing with group work, Mrs Khebs divided learners into four groups and gave them objects and basins half-filled with water. Settling learners for the group activity took her about six minutes because she was arranging groups and giving out materials for each. One would reason that it took her long to arrange for group work because it is not a common practice in her school. She asked them to pick the same materials they had in their groups and put them in water: "*Nkang lejoe le lephahamise* (*Take up the stone*). Learners did as they were told. She continued: "*Ha u nkile lejoe u le tšele ka metsing e be oa thola* (*When you have taken up the* *stone put it in water and keep quite*). Learners did as they were instructed and she went around to check: "*Joale le tlo phahamisa letsoho akere* (*Now you are going to put up your hand, isn't?*). Learners answered "*Yes*" collectively. Asked what had happened with the stone, learners raised their hands, and Phakiso (pseudonym) was chosen. The learner told the class that the stone had sunk in water and the teacher asked other learners to confirm whether this was correct. Learners agreed with Phakiso and the teacher asked learners to explain why that was. She referred them to the drawn pictures that she used when introducing the concepts of floating and sinking. One learner put up his hand and responded that it was because the stone was at the bottom of the water. The teacher asked other learners to applaud him for what she considered to be a correct response.

The lesson continued with the teacher asking learners to put other materials in water. Each was given a chance to put something in water. The teacher, together with the learners, checked and corrected one another when they got wrong answers. She explained to the learners that the pin sank in water because of the material out of which it was made. She explained: "*Lea bona na pin ee ea ka e kaenyana?* (*Do you see how small this pin of mine is?*) In unison, learners said: "*Yes teacher*."

She continued:

> *Mamelang hee. Lejoe le tibile hobane le le boima, feela akere oa bona lejoe leo le lenyane ho feta lebokose, empa lejoe le tebile. Pin ee, e tibile hobane e entsoe ka tšepe. Lintho tse entsoeng ka tsepe lia teba ka har'a metsi. …Lintho tse tebang ha re shebe weight haholoholo re sheba hore na li entsoe ka eng*" (*Listen to me, the stone sank in water because it is heavy, but you can see that the stone is smaller than the box, but the stone sank. This pin, sank because it is made of metal. Metal objects sink in water… When objects sink in water we do not look at their weight but we look at the kind of material they are composed of.*)

I found Mrs Khebs' explanation of why objects sink in water confusing. The narrative above refers to two things: "*the stone sank in water because it is heavy*" and "*When objects sink in water we do not look at its weight but we look at the kind of material they are composed of*." The two claims are contradictory, which shows that Mrs Khebs was unsure of why objects float in water and/or how to explain it. She stated that the stone sank because it was heavy, while at the same time she contradicted herself that the object's weight was not significant.

My analysis of Mrs Khebs' approach to teaching floating and sinking shows that she had deviated from her lesson plan even though the same activities she said she would use were reflected in her lesson presentation. This implies that she was probably not particular with her planning. Mrs Raiso and Mrs Haiso both deviated from their lessons by claiming that they would do something which did not align with either their planning or classroom practice.

The teachers' plan for group work, though not effectively used, aligns with Deniz and Adibelli's (2015) view that scientific learning is socially and culturally embedded. Data also show that the teachers' presentation of their lessons varied. Elements of teacher-dominated practice were evident in the way they delivered content, which resulted in their concluding for the learners on why objects floated or sank in water, even though their conclusions were misleading in most cases.

4.7.2.3. Learners' engagement

Evidence gathered from the teacher's lesson presentation points to the multiple efforts made to engage learners (lesson segments 1 and 5, and Section 4.6.1.1.2) in a meaningful discussion and enthusiastic participation with the teachers being more interactive than the learners. The two-thirds law postulated by Flanderl was evident in all the participants' classroom practice (Inamullah et al., 2008:46), according to which teachers often spend two-thirds of the time talking, directing, assigning instructions, and controlling the classroom, while the remaining one-third is spent by the learners responding to the teachers' instructions and engaging in active learning.

Of the four participants observed, the idea of knowledge construction was not evident as learners were not given adequate opportunities to take the lead by their teachers. Learners did not come up with new information based on the object that would float or sink in water. Instead, they discussed with their teachers the objects that would float or sink. For example, Mrs Haiso told learners that things made of metal would sink in water while Mrs Khebs told them that plastic bottles would float while glass bottles would sink in water. The discussion was more teacher-directed, with learner-receiving, meaning that if the information was not correct it would be a misconception that learners would retain.

Surprisingly, none of the participants organised their lessons so as to allow learners to ask questions on why certain objects floated or sank in water. Instead, all of the four participants told learners why objects floated or sank. Some of their explanations revealed that their content knowledge regarding floating and sinking was limited. For example, Mrs Raiso only told the learners that objects floated because they were light, which was misleading.

Only one participant, Mrs Khebs, implemented group work on the first day of observations. She had four groups, each of which had the same materials that were put in water to observe floating and sinking objects. Although the other participants also claimed that they used groups, the only time that was evident was when they asked learners to go to the activity corner to observe the experiment. This could be their way of controlling the learners so that they would all be able to see the activity, rather than using group work *per se*.

The data further show that no assignments were given to the learners on what they had learned about floating and sinking. All the four participants denied learners the opportunities to experiment on their own the floating and sinking exercise. It would have been more meaningful if learners had been given assignments to observe or be engaged in any activity related to floating and sinking, as that would ensure reinforcement of skills and synthesis of new knowledge.

Learners were not given opportunities to manage their own learning. The only opportunity that seemed to surface in the entire set of classroom observations was when learners were given opportunities to put the objects in water. Somehow, all the participants asked learners to correct other learners' mistakes when some said an object would float in water while actually it would not. This would have been a good starting point to promote construction of knowledge by the groups. It was, however, not pursued as such.

4.7.2.4. Resources

I observed Mrs Haiso five times on different days, teaching learners the concepts "float and sink." She had materials prepared for the learners to do the experiment on each day. These included water, a medium washbasin, pencil sharpener, pen, toy car, keys, plastic spoons and forks, metal spoons and forks, pins, piece of glass, tennis ball, and pair of scissors, coffee mug, plastic tumblers, metal earrings, toy duckling, coins, stones, leaves, bank notes, balloons, plastic pegs, marble and nails. According to Mrs Haiso, most of the objects were brought by the learners from home.

In the four days that followed Day 1, the same activity was repeated though a slight difference was noticed. For instance, Mrs Haiso asked learners to predict new materials that would float and sink in water other than the ones they had used the previous day. Learners mentioned them and again they were asked to put them in water to confirm their predictions. In explaining why objects float in water, Mrs Haiso said they floated because they have trapped air inside, like a balloon. The participant acted more as a source of information because she told learners why objects floated in water instead of letting them explore some explanations for themselves. This indicated a classroom practice that was mostly teacher-centred. Day 4 was handled differently from the previous three days as no water was used. Mrs Haiso asked learners to sort the objects on the activity corner, identifying the ones that floated or sank in water. As learners were sorting the objects she reminded them about the objects that would float and the ones that would sink, based on the reasons she gave on the previous days.

Similarly, Mrs Neuza had materials ready to be used in class. She brought a yo-yo, plastic bottles, coin, stone, paper, plastic shapes, sticks, bottle tops, a small amount of water compared to the materials collected, a ball, and screws. She introduced her lesson by quoting the story of Noah's Ark from the *Bible*. It was interesting to note that she was the only teacher to do so. The learners' questions and answers on the story continued until learners said that the boat was floating in water. She asked them: "*What are the other things that you think will float in water?*" Following learners' answers, she continued: "*Why do you think the other things float in water while the other ones will sink in water?*" Lineo (pseudonym) replied: "*I think the other one will float because they are too small and the other one will sink because they are too hard*." Lineo's response was similar to the findings by Andersson and Gullberg (2014) on how children conceptualise floating–sinking. These authors found that various misconceptions included the reflection that small learners think objects sink because they are hard. Learners were given a chance to state why they thought the objects would float or sink in water. After a number of learners had replied, Mrs Neuza told them that they were going to conduct an experiment to see which objects would float and which ones would sink. They gathered around the bowl of water as she was asking them to name the materials one by one as she put them in the water. She then asked them what was happening with the objects she was putting in water. Based on the observations, the learners told her, starting with a flat plastic square that sank, and the flat plastic kite which floated, Mrs Neuza was surprised. When noticing the teacher's reaction to the sinking plastic square, I asked her why she thought a kite floated while a square sank, despite being made of similar material. The participant answered: "*I really do not know what happened, I expected both shapes to float.*"

Mrs Neuza's day 1 was different from day 2 because she asked learners to bring materials that were found in the classroom. She asked them to put them on the mat and sort them according to the floating and sinking ones. This exercise took long because learners had many materials and mistakes were corrected by the teacher together with the learners. She instructed them to put those in water to confirm whether they were categorically placed under 'floating' or 'sinking.'

Observing Mrs Khebs's teaching, I noted that she had drawn pictures, which she showed to the learners to explain the concepts of floating and sinking, which was a unique teaching strategy of all the four cases.

<u>Lesson segment 6</u>

T: *Joale ntho tsa ka ke tsena, ha kere ha hona motho eo ke motsirileng*? (*Now, these are my objects, I hope I am not blocking anybody?*)

All: *Yes teacher*.

T: *Ke batla motho ea tlo mpontsa nthoe tibileng le ee phaphametseng nthong tsena tsa ka. Ha ke re ke metsi ke a. Ha ke re ke metsi moo, le mpontše na nthoena e phaphametse kapa e tibile. E tibileng ke efe e phaphametseng ke efe?* (after 10 seconds pause, she called *Sister Katleho* (pseudonym). *Sister Katleho ha mamela, ke batla u mpontše nthoe tibileng le e phaphametseng*. (*I want someone who will show me the floating and sinking objects from these objects of mine. This is water* (pointing at the picture)*. This is water here, show me whether the object is floating or sinking. Which one is floating and which one is sinking?* (after 10 seconds pause, she called Sister Katleho again (pseudonym). *Sister Katleho is not listening, I want you to show me a sinking and floating object*.)

Katleho: (showed the teacher silently the picture in which object sank in water).

T: *E etsang? Bontša likonyana*. (*What is it doing? Show other learners.*)

Katleho: *E tebile*. (*It is sinking*.)

T: *Sister Katleho o re ee e entse joang?* (*Sister Katleho says it does what?*)

All: E tebile. (*It is sinking.*)

T: *E eona?* (*What about this one*?)

Katleho: *E phaphametse*. (*It is floating.*)

T: *Sister Katleho o re ee e entseng?* (*Sister Katleho says it has done what?*)

All: *E tibile.* (*It is sinking.)*

She continued her lesson by asking learners to explain why they said objects in the pictures were either floating or sinking. Learners' responses were that floating objects were above water while sinking objects were beneath. She then announced that she wanted them to observe which things would float and which ones would sink. It was interesting to learn that the materials collected had been brought by the learners from home. The teacher told the learners that: "*Le itse lejoe lea teba ka metsing empa ha lea ntlela majoe a mangata*" (*You said the stone will sink in water but you did not bring me enough stones"*). The phrase "*ha lea ntlela*" (*you did not bring me*) implied that the teacher had asked learners to bring materials. Learners even told Mrs Khebs that the boxes she was distributing were from their homes. They gathered in groups and waited for the teacher's instructions.

All four participants used materials appropriate for the concepts of floating and sinking. Unique practices observed in Mrs Neuza's classroom included the reading of a *Bible* story to introduce the lesson while, in Mrs Khebs' lessons, it was the use of drawn pictures.

4.8. Integration of quantitative and qualitative findings

This section provides an integration of the quantitative and qualitative findings on how Lesotho Grade R teachers' science content knowledge appears to influence their classroom practices. The findings are gathered from the survey, interviews, observations and lesson plan analysis. The discussion on integration of findings is structured according to two major themes, namely, science content knowledge of Grade R teachers in Lesotho and teaching the selected science concepts (floating and sinking).

Science Content Knowledge of Grade R teachers in Lesotho

Quantitative results suggest that the teachers have the expected level of CCK as reflected by the results in Table 4.3 which show a high mean score quantified by 18 items while only 1 item, item 7 has a low mean score of 2.41 which is below average. The results for the qualitative phase also showed that “to some extent” teachers were able to explain what was floating and sinking during interviews and to the learners during classroom interactions. There was an exception of one participant, Mrs Haiso, whom I did not hear explaining to the learners the concepts of floating and sinking. She said she had presented the lesson the previous day, though I had expected to hear her explaining to the learners even if it was for the second time.

Both the quantitative and qualitative results corroborated the idea of insufficient SCK of Grade R teachers in Lesotho. In the quantitative part, this is revealed by items that were meant to uncover how much specialised knowledge the teachers would display on concepts of floating and sinking. The average mean scores for Table 4.4 (3.8) and Table 4.5 (3.42) were the lowest amongst the CK domains. Teachers were heterogeneous on explaining why objects floated in water. For instance, when asked in an interview why objects floated most said it was because they were *light*. None could relate to *force* as they admitted having no knowledge of forces that cause objects to float. This aligns well with mixed reactions on item 31 which says, “Clay that is shaped like a plate will sink in water.” and item 32 that says, “A true floating object must be completely above the surface of the liquid.” which had significant low mean scores and SD.

The quantitative results show mixed thoughts surfacing between respondents on the category of scientific skills. Item 33 required respondents to specify what would happen if many stones are put on a tray when demonstrating sinking and floating activity. Though most *agreed*, as reflected by 75%, 25% either *disagreed* or were *not sure*. During the pre-observation interview, one teacher did not know about the skills involved in teaching learners floating and sinking concepts. Teachers’ lesson plans showed some of the skills that would be engaged. It was evident in Mrs Haiso's poorly constructed lesson and Mrs Khebs' lesson activities that the skills were written even though not clearly outlined.

In both phases there was evidence that there is an alignment of results on the progression category that required teachers to indicate the concepts learners would learn in the upper grades. Table 4.6 shows that most teachers *agreed* on learners learning the concepts that addressed *density* and *force* (items 42 and 43). In the post-observation interviews with teachers, it was evident that one failed to connect floating and sinking concepts to those that would be dealt with later in the upper grades. Three of the teachers mentioned *density* and *force*. The quantitative data indicate a positive correlation between HCK and learner-oriented classroom practice (Table 4.8), however, the classroom observations mostly showed an indication toward teacher-oriented practice (lesson segments 1-6).

Amongst the five items that required Grade R teachers to elucidate whether they integrated floating and sinking with other learning areas, only one (item 37) had relatively high mean score, while others (items 34,35, 36 and 38) had comparatively low mean scores. This illustrates that teachers were less positive on the integration of the said concepts with other learning areas (Table 4.6). However, the qualitative results reported that all four participants seemed to know that it is possible to integrate floating and sinking with learning areas. They all indicated this in the pre-observation interview, though their planning reflected the contrary. They were not consistent with what they said they would teach in comparison with their planning. Accordingly, they knew about integration and therefore included it in their lesson presentation, even though it was not planned (Section 4.6.1.3.2).

Teaching the selected science concepts (floating and sinking)

Both the quantitative and qualitative results allude to engagement of different teaching methods used when teaching floating and sinking. Section 4.6.2.1.1 demonstrates that "questioning and answering," "discussion" and "demonstration" were the most planned methods in the qualitative phase, as well as in quantitative phase (Figures 4.11, 4.12 and 4.13). The quantitative part showed that teachers assessed learners (Item 60 and 61) with a high percentage of 95% and 73% respectively. During classroom interactions they did assess, even though their assessment did not seem to align with the planned objectives. Only one participant assessed as planned.

Table 4.7 of the quantitative phase shows that there were mixed reactions on most of the items asked. Figure 4.2 reveals how respondents expected learners to accept information given to them. The qualitative data showed elements of teacher-dominated practice as evidenced through the various lesson segments provided. All the participants saw themselves as the sources of information. Even the discussion in the classroom was more teacher-directed with learner-receiving. The way participants concluded their lessons was often misleading in terms of the accuracy of content (Section 4.6.2.1).

Table 4.8 of the quantitative data reveal that teachers engaged learners in the classroom. This is evidenced by a larger number of items in the learner-centred domain, as most items were higher than the average mean score. Only items 69, 70, 73 and 74 had a low mean score. Teachers seemingly were diverse in asking learners to assess their counterparts' work, with 24% who *disagreed*, 17% *neutral* and 59% who *agreed*. However, qualitative data reveal little engagement as teachers were more interactive than learners, spending much time on talking, directing and assigning instructions (lesson segments 1-6). Learners were engaged when they were following teachers' instructions. They did not construct their own knowledge, rather the participants told them that objects floated in water because they were light. A total of 92% of respondents agreed with the statement: "I ask learners to work in pairs or small numbers" revealing a learner-oriented practice. A similar observation was recorded in qualitative data, as all participants said they had used group work when only one had.

Both quantitative and qualitative findings corroborate the use of materials. Items 51 and 65 of the quantitative data show 91% and 95% of teachers *agreed* with bringing materials for floating and sinking activity. Both items have a high mean score and a low SD in comparison with the domains average mean and SD. Section 4.6.2.4 of the qualitative data indicates that participants used relevant materials for the concepts of floating and sinking. Mrs Neuza was alone in using a *Bible* story and Mrs Khebs drew pictures to introduce her lessons.

Influence of teachers' CK on classroom practice

Correlation and regression analysis (Tables 4.9, 4.10, 4.11, 4.12 and 4.13) suggest that there is a weak correlation between teachers' perceived common content knowledge (TPCCKSC) with learner-oriented classroom practice (LOCP) and teacher-oriented classroom practice (TOCP). Teachers' perceived specialised content knowledge on floating and sinking (TPSCKFS) has both weak correlation with TOCP and LOCP. However, teachers' perceived horizon content knowledge (TPHCK) has a weak correlation with TOCP but a moderate correlation with LOCP.

Lesson segments (1-5) presented under qualitative phase suggest that teaches' classroom practice were teacher-dominant. This is a finding similar to what Sun et al. (2014) in China that teachers were dominant in class talk and provided learners with less opportunities to participate in class. However, when asked in post-observation interview, all of them declared that their classrooms were both teacher-oriented and learner-oriented.

4.9. Summary

This chapter has presented data, analysis and findings of how Grade R teachers' science content knowledge (TSCK) in Lesotho influences their classroom practices. Since the study followed an explanatory sequential design, data were presented and analysed sequentially. Firstly, quantitative data were presented and analysed. The findings influenced the commencement of the second phase, data were gathered qualitatively to verify the findings of the first phase. A summary of integration of quantitative and qualitative results was presented separately for a clearer understanding. The results suggest that teachers' CK is fragmented. They have expected common content knowledge, limited specialised content knowledge and sufficient horizon content knowledge. Although teachers claimed to use learner-centred approaches, their practice was teacher-dominant.

The next chapter discusses the findings through the literature presented in Chapter two. It also explores implications of the findings, draws conclusions and makes recommendations for further research.

Chapter 5.
FINDINGS, DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1. Introduction

The aim of this study was to explore Lesotho Grade R teachers' science content knowledge and how it influences their classroom practices. The previous chapter presented and analysed data gathered from both quantitative and qualitative phases of this study. In this chapter, I discuss the findings, link them to the literature that is related to the theory discussed in Chapter 2 of this study. I draw conclusions, highlight implications and make recommendations for practice, policy and future research. The next section presents a summary of the whole study.

5.2. Summary of the study

This study explores how Lesotho Grade R teachers' content knowledge shapes their classroom practices. Shulman's Teacher Knowledge Framework and Content Knowledge for Teaching contributes to the framework and helps in understanding and explaining my topic. The discussions are built on pedagogical content knowledge (PCK) originally conceived by Shulman (1986) and extended by Ball et al.'s (2008) content knowledge (CK) domains. These are common content knowledge (CCK), specialised content knowledge (SCK) and horizon content knowledge (HCK). Pedagogical content knowledge is "the particular form of content knowledge that embodies the aspects of content useful to teaching" (Shulman, 1986:9). Content knowledge is defined by Shulman (2003) as teachers' knowledge about the subject, for instance, science concepts. Furthermore, CK helps in the delivery of subject matter or content as Jita (2016) argues that a teacher needs to have a comprehensive base of content knowledge to be considered competent in his or her subject area. How teachers' CK influences their practice (if any) would definitely be most evident in the classroom.

The need to embark on this study was driven by various motives such as my own background as an ECD practitioner and the literature review. The literature reviewed in this study suggests that prior studies that mapped teachers' science knowledge with their classroom practices were generally in the context of different levels of learning with little focus on early childhood learning and development. There is little documentation of preschool teachers' knowledge of science concepts and none of the studies reviewed indicate how the knowledge they have influences their practice. Therefore, interested scholars on issues concerning ECD teachers and their classroom practices will benefit from this study. The findings will also inform institutions that train preschool teachers and curriculum designers to strengthen or adopt issues of concern raised in this study.

Following a pragmatic philosophy to research, an explanatory sequential mixed-method approach was followed. I found a pragmatic paradigm useful in this research as I worked with the objective views of the teachers that guided me to dwell on their knowledge through interviews, observation and lesson plan analysis to deduce how their knowledge seems to influence their practices. Social factors such as classroom context and teachers' background contribute to construction of realities that could be attributed to classroom practices (Cohen et al., 2018). Therefore, the findings are developed to make sensible interpretations of analysed data, thereby deriving themes, categories and drawing conclusions from the findings.

The previous chapter presented teachers' content knowledge on science concepts (floating and sinking). It also highlighted how teachers teach those selected concepts. Through correlation and regression analysis, I was able to determine how teachers' knowledge influences their classroom practice. Below is the discussions of findings significant in this study.

5.3. Findings and discussions

The findings of this study are based on the study's aim to answer the main research question and sub-questions, which follow:

The main research question, as posed in Chapter 1, is:

> What is the influence of the science content knowledge of Grade R teachers in Lesotho on their classroom practice?

The following secondary research questions are used to complement the main research question:

1. What is the science content knowledge of Grade R teachers in Lesotho on selected science concepts?
2. How do Grade R teachers teach the selected science concepts to their learners?
3. How does teachers' content knowledge of science shape their classroom practice?
4. How can the Grade R teachers' content knowledge and practices in science be understood and/or explained?

I identified six key findings from the above three secondary research questions and discussed them in this chapter. They are (1) fragmented teachers' science content knowledge, (2) limited knowledge in use of teaching methods and strategies, (3) mismatch between teachers' lesson objective(s) and conclusion(s), (4) low learners' engagement in a lesson, (5) teachers' CK has weak or no influence on their classroom practices, (6) teachers' HCK influence learner-oriented classroom practices positively.

5.3.1. Science Content Knowledge of Grade R teachers in Lesotho

This theme aims to establish the findings of science content knowledge of Grade R teachers in Lesotho guided by the three (3) domains of content knowledge postulated by Ball et al., (2008).

5.3.1.1. Fragmented teachers' science content knowledge

The first important finding in this study reveals that the Lesotho Grade R teachers' science content knowledge is fragmented. It is explained by: (a) the expected common content knowledge, (b) the limited specialised content knowledge and (c) the adequate horizon content knowledge.

a) The expected Common content knowledge

This study found that Grade R teachers in Lesotho had the expected common content knowledge of floating and sinking concepts. The knowledge of these concepts was reflected in both Table 4.3 and in teachers' responses during pre-observation interviews (Section 4.6.1.1) in which they explained the concept of floating and sinking. The rationale for choosing floating and sinking concepts is included within the problem statement Section 1.2. In this context, knowledge of explaining floating and sinking is regarded as common content knowledge expected of any educated adult (Campton & Stephenson, 2014). This knowledge helped the teachers to explain the floating and sinking concepts to the learners, as can be seen in lesson segments 1, 2, 3, and 4**.**

The four participants in this study displayed adequate possession of CCK, with Mrs Neuza supposedly possessing the most subject matter knowledge of the four. She had studied the three branches of science in high school prior to deciding to become a teacher. Perhaps some of her interview answers were initiated by foundational knowledge partially acquired from her extensive subject matter knowledge. Although she possessed most content knowledge, her classroom practice was not different from other participants' practices because she was more of a director in controlling her class, as shown in Lesson Segment 3. This concludes with a significant finding that possession of extensive content knowledge in Grade R class does not necessarily make a teacher a progressive one, as was the case with Mrs Neuza.

b) The limited specialised content knowledge

My study also found that teachers were not able to explain why objects float or sink in water, which displayed limited SCK as explained in Chapter 2 and revealed in Table 4.4 and Table 4.5. This was discovered when teachers were asked to explain why a pin would sink in water while a boat made out of metal as the pin would float on water (Section 4.6.1.2). One teacher (Mrs Neuza) suggested that the boat would float because it was triangular in shape, confirming a misconception found by Havu-Nuuiten (2005) that floating and sinking is associated with the shape of an object. Mrs Raiso also had a misconception that a boat floats only because there is someone driving it, whilst a learner in Mrs Neuza's classroom indicated that the object sank because it was too hard. Left unrectified by the teacher, this and similar misconceptions voiced by the other participants support the one noted by Havu-Nuuiten (2005).

An observation made by Kiray et al. (2015) that teachers commonly allay that objects float because they are light and sink because they are heavy was reflected in the four teachers' classroom. Scientifically that was not sufficient as it is a root cause of misconception found in floating and sinking concepts (Zoupidis et al., 2016). Mrs Khebs was the only participant who gave the relevant explanation based on the level of the learners when they were asked to explain why they said the stone was sinking. One learner said "*it is because the stone was at the bottom of the water*" as it could be seen in the basin. It is significant to note this finding because when teachers have limited content knowledge of concepts, they have a tendency to attribute wrong meaning to the concept, which could be detrimental to the learners especially in early grades. The findings, therefore, support the understanding that teachers need to know not only the science they will teach learners but also more than the level at which they will teach them, and they will be able to answer unexpected questions confidently (Herbst & Kosko, 2012; Jakobsen et al., 2013; Markworth et al., 2009).

c) The adequate horizon content knowledge

The findings suggest that teachers' horizon content knowledge is adequate. A number of teachers knew some topics that grade R teachers would have studied in the upper grades while others did not, as indicated in Table 4.5. The qualitative study showed that teachers were able to connect concepts across curricula as they revealed that learners would learn about density and force in the upper grades (Section 4.6.1.3). Ability to connect the way concepts link is confirmed by Fernández and Figueiras (2014) and Jackobsen et al. (2013), as awareness of how topics relate over the span of the subjects included in the curriculum. In connection with what would be learnt in the upper grades, only one respondent, Mrs Haiso, could not relate floating and sinking to the concepts that would be taught in upper grades (Section 4.6.1.3). Lehrer et al. (2003) suggested that the concept of volume and density could be taught to grade 3s and 5s respectively if appropriate instructions is provided. Paik et al. (2017) agree that the concept of force could be introduced to middle school curriculum in relation to floating and sinking covered in lower grades, as confirmed by some of the participants.

The quantitative findings suggest that teachers were heterogeneous on integrating floating and sinking in literature and technology, with most agreeing to integrate numeracy and play opportunities while teaching (Table 4.5). This study concurs with Palaiologou (2016), for whom playful learning in ECD is key to helping children make sense of what they are learning. Lack of use of technology may indicate that teachers are not knowledgeable about technology, such that they are not aware of the benefits they would enjoy when incorporating it in their teaching. The qualitative data also suggests that the participants had knowledge of integrating content across curricula. Although this integration was evident in some cases, in others it was not. For instance, in the pre-observation interview with the participants they all indicated areas in which they would integrate floating and sinking with the purpose of emphasising its content. However, their lesson planning differed from what they said they would do. Mrs Raiso, Haiso and Neuza produced lesson activities that did not have integration of floating and sinking (Figure 4.3, 4.4 and 4.5), and only Mrs Khebs' lesson plan aligned with what she said she would do.

Cognisant of the expected common content knowledge, the limited specialised content knowledge and the adequate horizon content knowledge of Grade R teachers in this study is significant. It indicates that teachers have fragmented content knowledge which is not clearly demonstrated in literature because most studies highlight teachers' science content knowledge separately not as combined as in this study. Therefore, expected, limited and adequate content knowledge which this study define as "fragmented" CK if not considered would consequently affect the way teachers deliver science instruction (Oh & Kim, 2013). The significance of this finding is that curriculum designers, education authorities and college educators need to equip teachers with content knowledge as it is needed in every classroom.

5.3.2. Teaching the selected science concepts (floating and sinking)

The findings in this section are initiated by the second research question. They reveal that there is limited knowledge in using teaching methods and strategies, mismatch between teachers' lesson objective(s) and conclusion and low learners' engagement in a lesson. These findings are discussed below.

5.3.2.1. Limited knowledge in use of teaching methods and strategies

My study found that Grade R teachers had limited knowledge in use of teaching methods and strategies. They regard the whole lesson activity they used as group work because learners engaged in activities together. For instance, during the whole lesson interactions, learners picked materials one by one, confirming with other learners whether they had either floating or sinking objects. The way teachers conducted their lessons was expository because they were in charge of the lesson (Loyens & Rikers, 2011). The request "come and show us," or picking a learner by the name (lesson segments 1-6) meant that learners had no choice but to submit to their teachers. Not asking learners to work as a team is seen by Novilia et al. (2017) as denial of improving their acquisition of problem-solving and communication skills. The "give and take of talk" is believed to improve learners reasoning skills (Gillies & Boyle, 2010; Merce et al., 2009).

Three participants, Mrs Haiso and Mrs Raiso, said that they had used group work but neither indicated it in their lesson plans. Even their classroom activities did not indicate the use of group work. Only one participant (Mrs Khebs) engaged group work in one of her lesson, even though there were limitations in the way it was conducted. The key finding suggest that the participants in my study were aware of engaging progressive learning and thought they indeed used group work while they actually used the whole lesson activity.

I found that discussions, demonstrations, questioning and answering were commonly used by the participants (Figures 4.11, 4.12 and 4.13), however, they were more teacher-directed and learner-receiving. Seemingly, teachers allowed learners to memorise the information they gave them. For instance, they emphasised that objects floated because they were light and sank because they were heavy. They repeatedly asked learners to repeat after them so that they could memorise that information. Sophisticated methods and/or strategies such as dramatizing and singing were written by the teachers but not witnessed by myself as the researcher. Mrs Neuza claimed to have used a dramatizing method during learners' structured play in the fantasy corner. I did not have an opportunity to observe this due to the observation arrangement with the concerned participant.

It is significant to pay attention to the methods that teachers use in science classroom so that they conform to the inquiry-based learning since it had been regarded as the best method for teaching science (Lazonder & Harmsen, 2016) and allows for learners to engage in inquiring such that what they are doing would be meaningful (Setiawan & Siayah, 2020). It is also significant for teacher trainers to equip trainees with sound understanding of teaching methods so that they know for sure the method they employ and how to execute such methods.

5.3.2.2. Mismatch between teachers' lesson objective(s) and conclusion(s)

I discovered that there was an observable mismatch between teachers' lesson objectives and how they concluded the lessons when teaching the concept of floating and sinking. The mismatch is shown in the table below.

Table 5.1: Mismatch between objective(s) and conclusion(s)

	Objective	Conclusion	Finding
Raiso	At the end of this lesson, learners will be able to: identify an object that sink and that float.	Good, objects like plastic bottles will not sink because they are light and stones will sink because they are heavy.	The conclusion does not match the objective.
Haiso	At the end of the lesson learners should be able to: identify the sinking and floating objects.	Today we learnt about the sinking and floating objects.- We discussed why are they sinking and why are they floating	The conclusions do not match the objective.
Neuza	By the end of the lesson learners should be able to: mention objects that are floating and sinking in water.	Today we have learned about objects that are in water. They float in water because they are less dense than water, and others they are because of their shape.	The conclusion does not match the objective.
Khebs	At the end of the lesson learners will be able to: identify sinking objects from floating objects.	We identified the sinking objects from the floating objects and the pin, nails and (lemao) safety pin.	The conclusion matches the objective to some extent.

The mismatch confused the presentation of the lesson as the initial objective was not adhered to, rather the participants felt they needed to tell learners why objects were floating and sinking, which was not in their planning. Barendsen and Henze (2019) advise that teachers' strategies for teaching should align with lesson objective so that they achieve the desired learning outcome. However, the majority of participants refuted that as they did not align their objectives with what to conclude (Farrell, 2002). The significance of this finding is that teachers' lesson objectives and what they tell learners at the end of the lesson do not align. This implies that college lecturers and MoET field supervisors in Lesotho are not doing adequate groundwork to equip teachers with skills needed in their planning which would influence their teaching.

5.3.2.3. Low Learners' engagement in a lesson

Another finding suggests that learners participated only when they were required to do so. A two-thirds law by Flanderl which suggested that teachers occupied two-thirds while learners actively engage in one-third existed in all classrooms (Inamullah et al., 2008). Learners were denied opportunities to construct their own knowledge of why things floated or sank. Even though literature suggested that the learning environment in a learner-oriented approach should support learners by constructing their own knowledge (Baeten et al., 2013), that was not realised in participants' classroom. Again, learners' were deprived of opportunities to manage their own learning. In most classes, learners were asked to confirm whether their counterparts were correct or not, and if so, they clapped hands as a form of encouragement. For those who performed the activity incorrectly, rectification was instantaneous.

Learner-centred philosophies build on the idea that people learn best by doing something for themselves. Therefore, a class that builds on learner-centred teaching philosophies will seek ways to include experience in learners' education through hands-on activities or a field trip (Cheng et al., 2009). This finding is significant because direct participation and observation will enhance learning such that, as stated in MoET (2009), teachers should be facilitators of learning while allowing learners to assume greater responsibility for their own learning.

5.3.3. The influence of teachers' science content knowledge on their classroom practices

The findings in this section address the third secondary research question: How does teachers' content knowledge of science shape their classroom practice? The discussed findings are (1) Teachers' CK has weak or no influence on their classroom practices and (2) Teachers' HCK influence Learner-oriented classroom practices positively.

5.3.3.1. Teachers' CK has weak or no influence on their classroom practices

Another key finding indicates that TPCCKSC, TPSCKFS, have weak or no influence on Grade R teachers' classroom practices except TPHCK, which has moderate influence on classroom practice. Correlation analysis prepared in Table 4.9 and regression analysis responding to the combined influence of Lesotho Grade R Teachers' science content knowledge on their learner-oriented and teacher-oriented classroom practices confirm the weak relationship between both practices. All four participants had previous exposure to science concepts acquisition as they pronounced to have studied science in high school, although only one, Mrs Neuza, had studied the three branches of science. They studied science in one of their course modules at college as established by the interviews and literature review (Section 2.5). Teachers were able to explain the terms floating and sinking even though their approaches were different (Section 4.6.1.2). This finding significantly implies that though teachers may have sufficient CCK the Grade R teachers' common content knowledge has very weak or no influence on how they choose to construct their classroom practices. This calls for caution as there are other factors not discovered by this study that may have a more powerful influence on how teachers shape what they do in class than what they know in terms of the science content they teach.

The analysis organised on correlation (Table 4.9) and regression analysis (Table 4.12 and Table 4.13) respectively express that Teachers' Perceived Specialised Content Knowledge on Floating and Sinking (TPSCKFS) has no significant relative influence on Learner-Oriented Classroom Practice (LOCP) and Teacher-Oriented Classroom Practice (TOCP) with values respectively indicating ($B= -.046$, $t= -.470$, $p>0.05$) and ($B= -.164$, $t= 1.604$, $p>0.05$). Limitation of their SCK was reflected in Table 4.4 and Table 4.5 of this study.

Jakobsen et al. (2013) highlight that teachers have to be in the position to be able to answer the *why* question which could be raised by the learners. Although learners did not ask teachers *why* objects float or sink, they told learners that objects floated because they were light and sank because they were heavy. The finding by Jakobsen et al. (2013) lacked in this study as teachers did not prove themselves capable of knowing why objects floated or sank in water. Only one teacher (Mrs Haiso) said objects floated because they were lighter than water. Even though Mrs Haiso was the only teacher who told learners that objects would sink because they were “heavier than water,” a finding that suggests all four participants’ classroom conduct was similar in being expository in nature. Their comprehension of why things floated was thus transmitted to the learners as receptors of knowledge. Teachers were more active than the learners because they were simply dispensing information from their SCK which learners were expected to memorise. Teachers’ classrooms were like theatres, as they took over the stage with learners as captive audience waiting for the teacher to dictate information. When the information is “dished out” learners are bound to listen and the approach itself encourages teacher-oriented practice (Schreurs & Dumbraveanu, 2014).

Besides telling learners that objects floated because they were light and sank because they were heavy, they had their different interpretation of why things floated in water which they disclosed in a pre-observation interview. For instance, Mrs Haiso’s and Mrs Raiso’s explanations were that objects floated because they were light, while Mrs Neuza and Mrs Khebs indicated that objects floated because their density was less than that of water. The former explanation was misleading the learners while the latter was scientifically correct. The significance of this finding indicates that teachers’ limited SCK influenced them to give out misleading information. Therefore, it is imperative to understand that Grade R teachers need to be taught content relevant to what they are going to teach learners so that they would be able to explain concepts correctly and avoid misconception. Iserbyt et al. (2017) recommend teachers' exposure to professional development which could be organised by institution or the Ministry of Education and Training (MoET) to help teachers to acquire intended knowledge that would serve as a guidance for their science delivery.

5.3.3.2. Teachers' HCK influence Learner-oriented classroom practices positively

The findings of this study indicate that TPHCK has a weak correlation with TOCP ($r=0.19902$; $p=0.0471$) but a moderate correlation with LOCP ($r=0.42819$; $p<0.0001$). This means that TPHCK has influence on LOCP not on TOCP. Regression analysis on Table 4.12 confirms that TPHCK ($B= .323$, $t=3.021$, $p<0.05$) had the most relative influence on LOCP. Also, Table 4.13 shows that TPHCK ($B= -.050$, $t=-.443$, $p>0.05$) had no significant relative influence on TOCP.

Participants' classroom practices were observed as to whether they would seize the opportunity to integrate the floating and sinking concepts with other learning areas. They all did, but differently. For instance, Mrs Khebs asked learners to draw and colour the sinking objects on the given sheets, which raised learners' enthusiasm. They discussed with the teacher what they had drawn, even if the pictures were not clearly visible, and explained to their teacher what they had drawn excitedly. However, data showed that the teacher allowed learners to communicate what they understood with the teachers and thus enhanced their scientific skills. Mrs Raiso used much integration during her lesson presentation, asking learners to count how many floating and sinking objects they had. While learners were classifying them on the drawn table she guided them by identification of "f" for floating and "s" for sinking, thus using her HCK knowledge in class. Mrs Haiso and Mrs Neuza asked learners to count objects they collected for floating and sinking experiment. Therefore all of these activities happed in the classroom indicate that learners were engaged in their learning.

This finding is significant because it implies that there is a relationship between learner-oriented practice and HCK but a weak relationship between teachers' HCK and the teacher-oriented practice as reported in this section. The finding strengthens Setiawan and Siayah's (2020) view that the science classroom should be more learner-oriented than teacher-oriented, with teachers expected to engage learners in a constructive manner.

5.3.4. Explaining Grade R teachers' content knowledge and practices

This section discusses the responses to the following research question which anchors this study:

> How can the Grade R teachers' content knowledge and practices on science be understood and/or explained?

The influence of Grade R teachers' science content knowledge on classroom practices was explained by manipulating and understating data collected during both quantitative and qualitative phases through questionnaire, interviews, observations and lesson plan documents. The idea was to investigate how teachers construct their classroom practices influenced by the knowledge of content they had in science. The results from both quantitative and qualitative evidence suggest that the Grade-R teachers' content knowledge had very weak or no influence on how they decide on constructing their classroom practices (Tables 4.9, 4.10, 4.11, 4.12 and 4.13) as well as Section 4.6.1 and Section 4.6.2. This implies that there might be factors other than science knowledge that influence the way teachers conduct their classroom.

Various studies in which teachers' representations and explanations of the science content (Abd-El-Khalick, 2012; Kavalari et al., 2012; Spaull, 2013; Maboya, 2014) discovered that insufficient understanding of content limits teachers' capacity to explain and represent content in a sense-making way. This was also discovered by Makamure's (2016) findings in Zimbabwe, that mentors and college educators felt that their pre-service teachers lacked the knowledge of content they were going to teach, hence they were allocated lower level classes on teaching practice. In

South Africa, Rabaza (2016) confirmed that Mathematics teachers possess limited content knowledge of the *x* and *y* intercept and gradient and failed to explain them in a correct way. Setoromo et al. (2020) also found that Lesotho Grade R mathematics' teacher knowledge is limited. The aforementioned scholars concluded that the efforts of teachers with a limited content knowledge fail to equip learners with powerful conceptual understanding.

Studies in literature suggest that little content knowledge limits teachers' ability to explain concepts clearly to learners. This study concurs with that finding. However, the reviewed studies did not shed light on how science content knowledge influences practice. This study attempts to fill in the gap in existing literature by exploring whether knowledge influences practice, especially of pre-school teachers, which turns out to depict weak or no influence at all. Emerging factors which could be attributed to understanding and/or explaining how teachers' content knowledge in Grade R shapes the way they construct their classroom are as follows.

<u>Teachers' backgrounds influence the way they teach</u>

The first explanation of how teachers' content knowledge of and practices in science can be understood emanates from the finding that their various science backgrounds have an impact on how they teach in their classrooms. Two participants, Mrs Khebs and Mrs Raiso, claimed to have studied Biology in high school, while one, Mrs Haiso, studied Human and Social Biology. Only one respondent, Mrs Neuza, had studied Biology, Physics and Chemistry in high school. However, all regarded the science exposure they had at college to be helpful as they could relate their knowledge to what they were doing in the classroom. This concurs with Palmer et al*.* (2015) and Lynd (2005), who suggest that teacher training institutions positively influence teachers' delivery of science content because there are opportunities for learning information regarding content, learning skills and strategies for teaching, being hands-on in activities, working in groups and taking part in classroom discussions.

However, I learnt that content addressing floating and sinking was not dealt with in the participants' attended college, which is LCE. They only concentrated on the methodology of how they would teach learners science concepts. Mrs Haiso's testimony declared: "*We were taught how to teach children*." Although the data suggests that teachers might only have been taught methodology of teaching science, Mogari et al. (2009) believe that institutions should offer content sufficient for the teachers to execute their teaching. This concurs with Clermont et al. (1994), who found that teachers' knowledge and skills could be enhanced during intensive short-term or skill-oriented workshops, as was the case with Grade R teachers who had earned a certificate from LCE. Mrs Neuza commented: "*Before I went to the college, I just taught some things without doing the experiments.*" Similarly, Mrs Khebs said: "*Now I am able to do activities and experiments*." This is in agreement with Demirdöğen et al. (2016) and Mokhele and Jita (2010), who recommend continuing professional development (CPD) as it reinforces teachers' pedagogical content knowledge and brings about change in a way teachers conduct teaching in their classroom. All the participants specified that the "know-how" received at college contributed much to their ability to teach science concepts. This finding is significant because teachers' understanding of concepts is mainly influenced by the exposure they experienced. As a result, it calls for education authorities in Lesotho to support Grade R teachers with CPD to enhance their knowledge of concepts as deemed important by this research.

<u>Knowledge of content</u>

This study established an explanation that teachers' CCK concerning conceptual understating of floating and sinking was sufficient, as confirmed by both quantitative and qualitative studies (see Table 4.3 and Section 4.6.1.1). The finding concurs with those of Ball et al. (2008) and Campton and Stephenson (2014), who specify that any adult who went to school possesses some CCK. The participants clearly explained the concepts of floating and sinking to me, which in turn helped them to do so to the learners.

Another specific finding suggests that teachers' SCK was limited, as revealed in the quantitative SCK domain section when teachers were unable to decide on statements that required their conceptual knowledge of floating and sinking (Table 4.4 and Table 4.5). The qualitative section clearly indicated that teachers gave learners incorrect information (Section 4.6.1.2.1), substantiating Setoromo et al. (2020), for whom teachers are in danger of teaching inaccurately and reinforcing misconceptions when they do not have sufficient SCK. For instance, Grade R teachers continued telling learners that objects floated because they were light and sank because they were heavy.

Science concepts taught at LEC for pre-school teachers concentrated more on pedagogy than on content (Section 4.6.1.1.1), which tends to create a vacuum between teachers' knowledge of the subject and how they would teach it. As a result, Grade R teachers may have problems with science content delivery during teaching. Therefore, this study supports an understanding that Grade R teachers need to be taught more content, even if it is more than what they are expected to teach in the classroom. That will enable them to answer unexpected learners' questions confidently.

Another specific finding on Grade R teachers' HCK illustrates that some teachers had adequate knowledge of HCK across curricula. This is evidenced in Section 4.6.1.3.1 and Table 4.6. The qualitative data showed that only one participant failed to relate floating and sinking concepts to density and force that would be taught in the upper grades. The adequate knowledge was seen when teachers integrated science content with other learning areas in Section 4.6.1.3.2. Again, some participants included counting the floating and sinking objects as well as emphasising plural form for the objects that were used in teaching the concepts. Sufficient HCK is in concurrence with what Fernández and Figueiras (2014) regard as vigilance of connecting related topics across the subjects included in the curriculum, which teachers lacked.

Lesson preparations and presentations

Another understanding that is revealed by this study indicates that the Grade R teachers' practice was more teacher-dominated than learner-oriented, partly because the breadth and depth of their conceptual understanding of science content was limited. From the classroom observations it was evident that participants spent about two-thirds of their teaching directing and telling learners what to do (Inamullah et al., 2008). This finding confirms the argument by Russell-Bowie (2012), that when teachers teach unversed topics they express more misconceptions as they talk longer and pose low order questions. This finding compromises the envisaged and/or perceived role of the science teacher as the focus should be on equipping learners with content and developing science skills. Opportunities for learner engagement in the classroom have been highlighted in literature (Godec et al., 2018; Lawson & Lawson, 2013; Hampden-Thompson & Bennett, 2013), with some learners struggling to understand concepts taught in science classrooms. It is believed that learners bring their experiences in the classroom, therefore, if they are denied opportunities to engage with science concepts, the learning would be blurred and unconnected to the lesson.

Another general finding indicates that lesson objectives, activities, assessment and conclusions were poorly aligned. A finding consistent with Ghanaguru et al. (2017) that indicates that CK affects the way teachers plan. For instance, embedded misconceptions in planning would consequently be transferred to learners as they were taught content. Figure 4.14 of Mrs Raiso's lesson conclusion reflects such planning. In agreement with haphazard planning, Osborne and Simon (1996) emphasise that it is due to the level of subject matter knowledge which affects the way the teacher organises, implements and delivers content. It is reflected in the provided lesson segments of this study, in which the participants did not engage learners in a dynamic way. Mrs Raiso spent more than 40 minutes in a lesson that was supposed to take 30 minutes because she could not translate her learning activities in a meaningful way. Most of what she taught was not in her lesson plan. In most of the participants' planning there was no fluency in aligning objectives with activities, assessment or conclusion.

Another general finding of this study suggests that Grade R teachers perceived themselves as engaging both learner- and teacher-oriented approaches in their classroom. This emerged during the post-observation interviews. The participants claimed to have used the hybrid approach even though that did not happen in their classroom. The findings showed that students were viewed as *tabula rasa*, who passively received knowledge from their teachers. Gillies and Nichols (2015) argued that learners are not "empty vessels" who come to class with nothing in their minds, unable to develop their problem-solving, critical thinking and decision-making skills. Teachers view themselves as knowledgeable in terms of combining teacher- and learner-centred approaches, regardless of what they displayed. This was incongruent and inconsistent with the level of SCK confirmed in Table 4.9, which indicates that SCK has both weak correlation with teacher-oriented and learner-oriented classroom practices, their p-values being (p=0.1075) and (p= 0.2196) respectively. Traditional teaching techniques, such as learners repeating what the teacher said and memorizing the content they were told, featured in all the classrooms that were observed. To reflect their supposedly hybrid approach, the participants claimed to have used group work, though Mrs Khebs was the only respondent who to some extent clearly used it in her classroom.

One more general finding relates to the issue of using mother tongue, as evident in Mrs Khebs' classroom. She spent most of her lesson teaching in Sesotho, the home language for Basotho. Unlike other observed participants, her learners seemed to grasp content more quickly when taught in their first language. Although this study focused on Grade R, it refutes concerns by Kallery and Psillos (2001) that language could be a serious impediment to learning science as there might be misuse of scientific language and misleading and confusing expressions contained in the teachers' statements.

<u>The influence of content on practice</u>

The general finding of this study suggests that the Grade-R teachers' content knowledge had little or no influence on how they choose to construct their classroom practices. This is shown by the combined influence of the predictors

(TPCCKSC, TPSCKFS and TPHCK) which had no significant influence on TOCP ($F_{(3,92)} = 1.175$; $P > 0.05$). Amongst the three predictors, only TPHCK had relative influence on LOCP (B= .323, t=3.021, p<0.05) while others (TPCCKSC and TPSCKFS) had no significant relative influence on LOCP (B= .033, t=.308, p>0.05, B= -.046, t= -.470, p>0.05).

Qualitative findings established that even though teachers may have more CK as directed to Mrs Neuza, the way she conducted her classroom was no different from other teachers. A finding that negates that of Abd-El-Khalick (2012), Kavalari et al. (2012), Spaull (2013) and Maboya (2014) that when teachers have sufficient content knowledge, they are able to explain and represent content in a sense-making way. Caution should be stated that there may be other more powerful influences not discovered by this study that shape what teachers do in the class than what they know in terms of the science content they teach.

5.4. Conclusions

The major aim of embarking on this study was to establish the science content knowledge of Grade R teachers in Lesotho and how such knowledge influences their classroom practices by asking teachers to respond to questionnaires and interview questions, as well as observing them in their classroom setting and analysing their lesson plans.

From the research findings, it was evident that Grade R teachers in Lesotho possess limited science content knowledge. This finding is in line with previous scholarship (Kallery & Psillos, 2001; Justi & Gilbert, 2002; Tairab, 2010), though their studies concentrated more on elementary and high school teachers. Kallery and Psillos (2001) conducted a study on how Greek pre-school teachers' SCK prepared them to answer learners' everyday science questions in the classroom. Though the focus was on teachers' science knowledge it was aligned to how teachers responded to pre-school learners' questions not to a specific topic as in this study. They found poor levels of science knowledge in teachers.

The limited content knowledge was due to an indication that teachers' SCK was inadequate as some could not respond to questions that required their SCK in both the quantitative and qualitative studies. They taught learners that objects float because they are light and sink because they are heavy, a misconception that was found to surface in most studies of elementary teaching. This impacts negatively on learners, since it would be difficult to erase in the learners' minds any incorrect information they had picked up from their teachers. Again, teachers' HCK was disjointed as some clearly did not know what aligned with floating and sinking concepts that could be taught in upper classes. However, amongst the three domains of CK deliberated in this study, Grade R teachers had an expected level of CCK.

Owing to the differentiated CK, teachers' classroom practice was rather influenced by some factors other than their science content knowledge. For instance, contextual circumstances in the classroom led teachers to turn to teacher-oriented practice, denying learners an opportunity to engage actively or interact with others and the environment during teaching and learning (Tomlinson, 2014). Previous studies, conducted by Raselimo (2010) and Nketekete and Motebang (2008) in Lesotho, found teacher-centred pedagogy to be a common practice. Rote learning that was displayed in most of the classes observed explains the low level of teachers' CK in practice. For learners to develop a deep understanding of scientific explanations of the natural world, they need sustained opportunities to work with and build on the concepts that support these explanations, thus understanding the connections between concepts (Michaels et al., 2014).

This study concludes that Lesotho Grade R teachers' science content knowledge has weak or no influence on how they choose to construct their classroom practices. These practices can only be understood or explained in terms of the inter-related factors and conceptual framework raised. They include teachers' exposure to science knowledge or training, and though Mrs Neuza had possession of more CK than her counterparts, her practice was not as different as expected. CK domains namely: CCK, SCK and HCK, used in this study, twisted teachers' classroom practice such that it swayed the way they planned for content delivery, how they engaged learners in the classroom, their classroom activities, use of available materials and the way they assessed and concluded their lessons.

This study proposes a new model based on the research findings and science teachers' content knowledge and classroom practices, adapted from views of Ball et al. (2008) on mathematical content knowledge for teaching. The proposed model, restructured to suit the findings, seeks to engage science teachers' practices in a learner-dominated way.

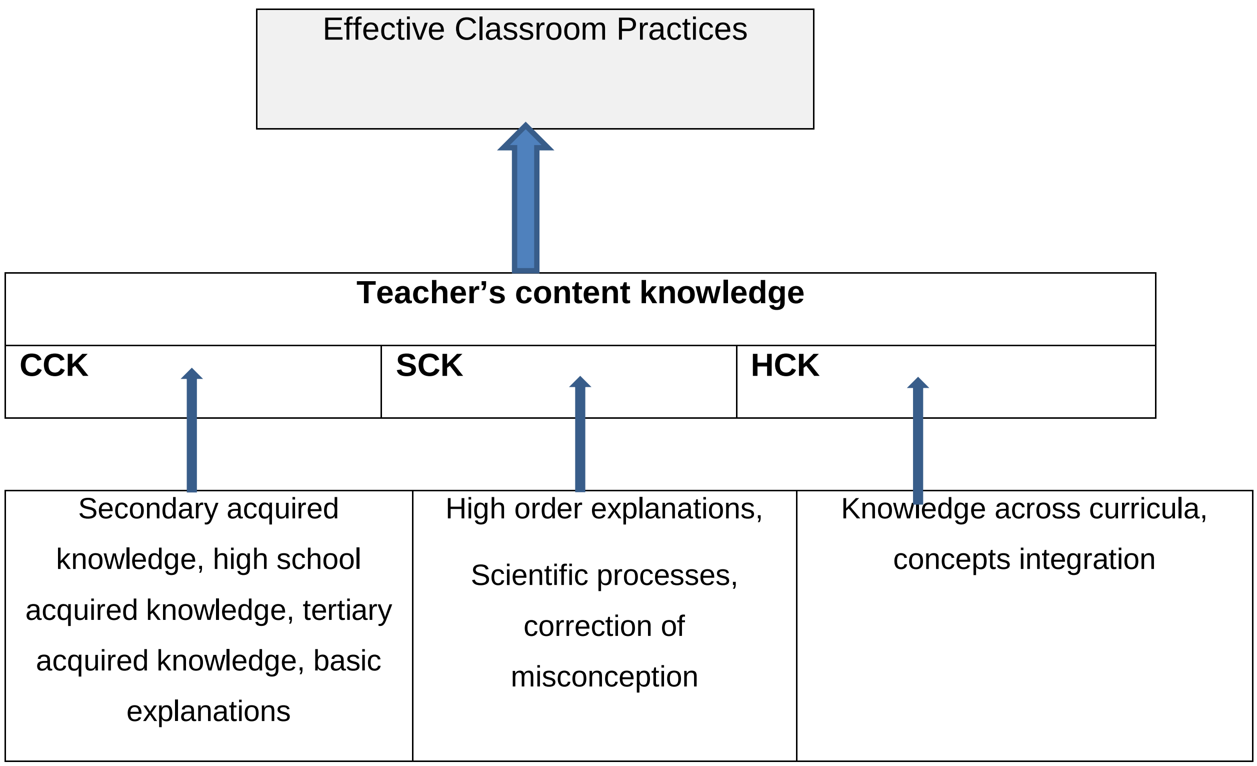


Figure 5.1: Proposed model for effective classroom practice influenced by teachers' science content knowledge

Figure 5.1 above shows the hierarchical flow of conceptions that built up teachers' content knowledge and has an influence on their classroom practices. Teachers' CCK, as found from this study, showed that teachers acquired it from exposure in secondary, high school and tertiary institutions (Section 4.6.1.1.1). That knowledge was sufficient to equip teachers with basic science concepts. Their SCK would be demonstrated if they were able to give clear explanations to learners, thereby answering challenging questions. The demonstration would further be revealed if the teacher was able to execute scientific processes as well as correcting learners' misconceptions. Again, teachers' HCK would be shown when the teacher had knowledge of concepts that relate across curricula (Section 4.6.1.3.1) and was able to integrate the taught concepts into other learning areas, as shown in Section 4.6.1.3.1. If teachers are well versed in the three domains of CK, their classroom practice would be effective in promoting learning and participation from learners. Therefore, I recommend that the proposed model be the relevant approach in addressing the research problem.

The proposed model for effective classroom practice influenced by teachers' science content knowledge is the present study's contribution to the scholarship of research. Limited content knowledge leads teachers to communicate misleading information to learners, as displayed in this study. The model tries to address the misconceptions rooted in teachers' knowledge which is transferred to the learners. This study is new in Lesotho and is one of its kind as it focuses on the early childhood education sector. Other studies conducted before established teachers' CK in elementary schools, high schools and tertiary institutions. In this study, the new body of knowledge should contribute to early childhood learning and science teaching.

5.5. Implications and recommendations for practice, policy and future research

This section discusses possible implications from the findings and makes recommendations for how Grade R teachers' science content knowledge can be improved so that the gap between theory and practice could be narrowed. Policy and future research recommendations are also made.

5.5.1. Implications from the findings

The level of ECD teachers' CK regarding their exposure to science concepts has possible implications that influence their practice. For example, teachers who enrolled for the Certificate in Early Childhood Education (CECE) seemingly have low levels of educational requirements, as can be seen in LCE official calendar document indicating that even the candidates who had a second class pass in Junior Certificate could apply (LCE, 2019). This means that teachers who enrolled in the programme might not have high school level science content that would help them teach in class. They might have finished their schooling at secondary level, thus their only source of hope in this circumstance would be a teacher training institution.

5.5.2. Recommendations for practice

In light of the above, the study recommends that the college syllabi be reviewed to include the core science content that teachers are going to teach at school. This needs to be implemented in such a way that there will be a flow of taught concepts between the colleges' curriculum and the school curriculum. However, caution should be taken when developing content to answer the needs of teachers that would not match the needs of the learners. The core science content that Grade R teachers need should be above the level they are going to teach in order to enhance their confidence.

Moreover, the results clearly suggest that Grade R teachers may need further background in scientific knowledge presented at the teacher training college. The content-oriented programme will raise the content aspects of these teachers. Their knowledge of content in any area is of the utmost importance. If teachers have the expected CCK, it does not mean that their SCK and HCK should not be looked at. If any of the said components are weak, their skills and confidence level in delivering content would also be weak. This study recommends that the three content knowledge domains CCK, SCK and HCK be treated equally as they all embrace effective classroom practice. Therefore, increasing the level of comprehension of science concepts among ECD teachers would be a worthy goal for a teacher education programme.

5.5.3. Recommendation for policy

The study showed that Mrs Raiso had one lesson plan for a week, which was neither guiding nor up to standard in terms of the content that would be taught to the learners and learners' activities. As other lesson plans that were analysed from the participants were not constructed the same, Mrs Haiso's lesson plan activities (Figure 4.5) were poorly constructed. This study recommends there be a guiding policy in schools whereby teachers would prepare their lessons daily so that they go to class prepared with sufficient content and information that is not misleading. The prepared lessons should be signed off by the Head of department, senior teacher or principal who is well versed in planning and ECD curriculum.

The implementation of an ECD policy and strategic plan on teaching and learning that advocated expansion and training of ECD professionals for both the diploma and graduate courses should receive more support from the government and the Council on Higher Education (CHE). Moreover, the regulatory agencies of the government, such as CHE and the Department of Education through Integrated Early Childhood Care and Development (IECCD) unit, should set up a quality assurance and regulatory unit to oversee the support of pre-school teachers at the college and in schools to strengthen understanding of the subjects and their applications.

5.5.4. Recommendations for future research

The study recommends a longitudinal study along with a wider sample of pre-school teachers of three to five year-old learners to allow for longer and more differentiated collection of data. More and extended findings will be obtained when larger samples are used. Those teachers could be absorbed into a professional development programme in which thorough training of science concepts could be engaged. After training, their new science content knowledge could be used to find out how it influences their classroom practice. Iserbyt et al. (2017) also recommend a workshop in professional development.

For the feasibility of this study, floating and sinking concepts were used. As a result, in-depth research can also be conducted using more specific science topics to explore pre-school teachers' science content knowledge. The results would be valuable to science teacher trainers and instructional material designers in improving student-teachers' learning in this area.

5.6. Final thought on the study

The study provided an opportunity to explore the Lesotho Grade R teachers' content knowledge and how it influenced their classroom practices. It seems to be more of a "hit and miss" for the teachers rather than a well-thought out construction of classroom practice based on their content knowledge of science. Through this study I learned much and understood how teachers operate in the field, nurturing young learners to develop skills needed in science and the misfortune the learners have in being taught misconceptions that resulted from teachers' limited science knowledge. This study revealed that science contextual learning is needed, which requires constant examination in order to maintain the correct levels of scientific knowledge and skills.

The key insights gained in conducting this study helped me to clarify thoughts and generate new insight into science teaching in the early childhood setting in Lesotho. As a teacher educator, I learned that teacher training has some impact on teachers' conceptual understanding of the subject matter. The quality of the teacher role is somewhat related to the content and quality of guidance provided by the teacher training colleges.

CK as a knowledge base coupled with the addressed science concepts in this study will equip researchers interested in matters concerning ECD to be more vigilant in this area. The Ministry of Education and Training in Lesotho, through its Integrated Early Childhood Care and Development Unit, needs to continuously review the curriculum to suit the needs of both learners and teachers at schools. The policymakers need to develop policies that would enhance learning in the classrooms. All these could be realised by expanding and training more Early

Childhood Development professionals for better engagement with content. In conclusion, I am personally motivated to investigate further how pre-school professional development on science concepts would shape teachers' classroom practices for the better.

References

Abd-El-Khalick, F. 2012. Examining the sources for our understandings about science: Enduring conflictions and critical issues in research on nature of science in science education. *International Journal of Science Education*, 34(3), 353-374.

Abd-El-Khalick, F. & BouJaoude, S. 1997. An exploratory study of the knowledge base for science teaching. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 34(7), 673-699.

Ahmad, H. & Halim, H. 2017. Determining Sample Size for Research Activities. *Selangor Business Review*, *2*(1), 20-34.

Airasian, G. M. 2014. *Educational Research: Competencies for Analysis and Applications*. United States of America: Pearson.

Akçay, N.O. 2016. Determining the Views and Adequacy of the Preschool Teachers Related to Science Activities. *Universal Journal of Educational Research*, 4(4), 821-829.

Akoto-Baako, H. 2018. *Perceived influence of large class size and psychological classroom environment on students' academic performance* (Doctoral dissertation, University of Cape Coast).

Alvesson, M. 2010. *Interpreting interviews*. Sage.

Amankwaa, L., 2016. Creating protocols for trustworthiness in qualitative research. *Journal of Cultural Diversity*, *23*(3).

Anderson, D. 2015. The nature and influence of teacher beliefs and knowledge on the science teaching practice of three generalist New Zealand primary teachers. *Research in Science Education*, 45(3), 395-423.

Andersson, K. & Gullberg, A. 2014. What is science in preschool what do teachers have to know to empower children? *Cultural studies of science education*, 9(2), 275-296.

Arendse, L. 2011. The school funding system and its discriminatory impact on marginalised learners. *Law, Democracy and Development*, 15(1), 339-357.

Arslan, H.O., Cigdemoglu, C. & Moseley, C. 2012. A three-tier diagnostic test to assess pre-service teachers' misconceptions about global warming, greenhouse effect, ozone layer depletion, and acid rain. *International journal of science education*, 34(11), 1667-1686.

Baeten, M., Struyven, K. & Dochy, F. 2013. Student-centred teaching methods: Can they optimise students' approaches to learning in professional higher education?. *Studies in Educational Evaluation*, 39(1), 14-22.

Ball, D.L. & Bass, H. 2002. Toward a practice-based theory of mathematical knowledge for teaching. In *Proceedings of the 2002 annual meeting of the Canadian Mathematics Education Study Group* (pp. 3-14). Edmonton Alberta.

Ball, D.L., Thames, M.H. & Phelps, G. 2008. Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5), 389-407.

Barendsen, E. & Henze, I. 2019. Relating teacher PCK and teacher practice using classroom observation. *Research in Science Education*, 49(5), 1141-1175.

Bartos, S.A. & Lederman, N.G. 2014. Teachers' knowledge structures for nature of science and scientific inquiry: Conceptions and classroom practice. *Journal of Research in Science Teaching*, 51(9), 1150-1184.

Basheer, A., Hugerat, M., Kortam, N. & Hofstein, A. 2017. The effectiveness of teachers' use of demonstrations for enhancing students' understanding of and attitudes to learning the oxidation-reduction concept. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(3), 555-570.

Beaumont, J. 2010. A sequence of critical thinking tasks. *Tesol Journal*, *1*(4), 427-448.

Beijaard, D. & Verloop, N. 1996. Assessing Teachers' Practical Knowledge. *Studies in Educational Evaluation*, 22(3), 275-86.

Bell, T. L. 2002: *Doing your Research Project: Principle and Practice*. Philadelphia: Open University.

Beni, S. 2014. Foundation Phase Teachers' Interpretation and Implementation of the Natural Science Curriculum in the Life Skills Learning Programme: A case study (PhD thesis). Durban: University of KwaZulu-Natal.

Bhargava, A. 2009. Teaching Practice for Student Teachers of B. Ed Programme Issues, Predicaments and Suggestions. *Turkish Online Journal of Distance Education*, 10(2), 101-108.

Biggs, J. 2003. Aligning teaching and assessing to course objectives. *Teaching and learning in higher education: New trends and innovations*, *2*(April), 13-17.Blythe, S.G. 2015. *The genius of natural childhood: secrets of thriving children*. Hawthorn Press.

Brickhouse, N.W. 1990. Teachers' beliefs about the nature of science and their relationship to classroom practice. *Journal of teacher education*, 41(3), 53-62.

Britto, P.R., Lye, S.J., Proulx, K., Yousafzai, A.K., Matthews, S.G., Vaivada, T., Perez-Escamilla, R., Rao, N., Ip, P., Fernald, L.C. & MacMillan, H. 2017. Nurturing care: promoting early childhood development. *The Lancet*, 389(10064), 91-102.

Bromme, R. 1995. What exactly is pedagogical content knowledge? Critical remarks regarding a fruitful research program. *Didaktik and/or curriculum. IPN Schriftenreihe*, 147, 205-216.

Broström, S. 2015. Science in early childhood education. *Journal of Education and Human Development*, 4(2), 107-124.

Brown, L. 2010. Balancing risk and innovation to improve social work practice. *British Journal of Social Work*, 40(4), 1211-1228.

Bulunuz, M. 2013. Teaching science through play in kindergarten: Does integrated play and science instruction build understanding? *European Early Childhood Education Research Journal*, 21(2), 226-249.

Burnette, M. 2017. Tacit knowledge sharing among library colleagues: a pilot study. *Reference Services Review*.

Campbell, C. & Chealuck, K. 2015. Approaches to enhance science learning. *Science in early childhood*, pp.67-84.

Campton, I. & Stephenson, M. 2014. Partnering theory and practice in mathematics teaching. In R. Hyde & J. A. Edwards (Eds.), *Mentoring Mathematics Teachers: Supporting and inspiring pre-service and newly qualified teachers*. Abingdon: Routledge.

Carter, K. 1990. Teachers' knowledge and learning to teach. *Handbook of research on teacher education*, 2, 291-310.

Çepni, S. and Şahin, Ç. 2012. Effect of different teaching methods and techniques embedded in the 5E instructional model on students' learning about buoyancy force. *International Journal of Physics & Chemistry Education*, *4*(2), pp.97-127.

Chan, K.W. 2016. Enhancing the effectiveness of small class teaching through innovative learning environments in Hong Kong schools. *Class Size: Eastern and Western perspectives*, p.247.

Chan, K.W. & Elliott, R.G. 2004. Relational analysis of personal epistemology and conceptions about teaching and learning. *Teaching and Teacher Education*, 20(8), 817-831.

Cheng, M.M., Chan, K.W., Tang, S.Y. & Cheng, A.Y. 2009. Pre-service teacher education students' epistemological beliefs and their conceptions of teaching. *Teaching and Teacher Education*, 25(2), 319-327.

Clermont, C.P., Borko, H. and Krajcik, J.S. 1994. Comparative study of the pedagogical content knowledge of experienced and novice chemical demonstrators. *Journal of Research in Science Teaching*, 31(4), 419-441.

Cohen, L. M., Manion, L. & Morrison, L. K. 2011. *Research Methods in Education.* London: Routledge.

Cohen, L. M., Manion, L. & Morrison, L. K. 2018. *Research Methods in Education. 8Th Ed.* London: Routledge.

Collins English Dictionary. 2014. *Floating. – Complete and Unabridged, 12th Ed.* (https://www.thefreedictionary.com/floating) Retrieved on 21 March 2020.

Committee for the Review of Teaching and Teacher Education. 2003. *Australia's* *teachers: Australia's future, Advancing innovation, science, technology and mathematics.* Canberra: Department of Education, Science and Technology.

Creative Research Systems. 2012. *Sample Size Calculator*. https://www.surveysystem.com/sscalc.htm Retrieved on 16 January 2018.

Creswell, W. J. 2014. *Research design, Qualitative, Quantitative and Mixed Methods Approaches.* 4th ed. London. Sage.

Creswell, J.W. and Creswell, J.D. 2018. *Research design: Qualitative, quantitative, and mixed methods approaches*. 5th Ed. Thousand Oaks, CA Sage publications.

Creswell, J. W. & Plano Clark, V. L. 2011. *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publication.

Curriculum and Assessment Policy Statement (CAPS). 2011. *Curriculum and Assessment Policy Statement. Grades R – 3*. Basic Education Department: Republic of South Africa.

Darling-Hammond, L. 2017. Teacher education around the world: What can we learn from international practice? *European Journal of Teacher Education*, 40 (3) 291-309.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B. & Osher, D. 2020. Implications for educational practice of the science of learning and development. *Applied Developmental Science*, *24*(2), 97-140.

Davies, D. & McGregor, D. 2016. *Teaching science creatively*. Routledge.

DeLuca, C., & Hughes, S. 2014. Assessment in early primary education: An empirical study of five school contexts. *Journal of Research in Childhood Education*, 28, 441-460.

De Jong, O. & Van Driel, J. 2004. Exploring the development of student teachers' PCK of the multiple meanings of chemistry topics. *International Journal of Science and Mathematics Education*, 2(4), 477.

Demirdöğen, B., Hanuscin, D.L., Uzuntiryaki-Kondakci, E. & Köseoğlu, F. 2016. Development and nature of pre-service chemistry teachers' pedagogical content knowledge for nature of science. *Research in Science Education*, 46(4), 575-612.

Deniz, H. & Adibelli, E. 2015. Exploring how second grade elementary teachers translate their nature of science views into classroom practice after a graduate level nature of science course. *Research in Science Education*, 45(6), 867-888.

Dentici, O.A., Grossi, M.G., Borghi, L., De Ambrosis, A. & Massara, C.I. 1984. Understanding floating: A study of children aged between six and eight years. *European Journal of Science Education*, 6(3), 235-243.

Department of Education (Australia). 2018. *Teacher qualification and registrations*. Department of Education: Australia.
(det.wa.edu.au)
Retrieved on 29 September 2018.

Department of Education (South Africa). 1997. *White Paper 5: Early childhood education, grades R-3.* Pretoria: Government Printer.

Department of Education (South Africa). 2003b. *Revised National Curriculum Statement, Grade R – 9 (schools) Teacher's guide for the development of learning programmes: Foundation Phase*. Pretoria: Government Printer.

Department of Education (South Africa). 2011. *Curriculum and Assessment Policy Statement (CAPS). Natural Science and Technology, Grades 4-6.* Pretoria: Government Printer.

Diamond, B.S., Maerten-Rivera, J., Rohrer, R. & Lee, O. 2013. Elementary teachers' science content knowledge: Relationships among multiple measures. *Florida Journal of Educational Research*, 51(1), 1-20.

Diamond, K.E., Justice, L.M., Siegler, R.S. & Snyder, P.A. 2013. Synthesis of IES Research on Early Intervention and Early Childhood Education. NCSER 2013-3001. *National Center for Special Education Research*.

Dickson, M., Kadbey, H. & McMinn, M. 2015. Comparing Reported Classroom

Practice in Public and Private Schools in the United Arab Emirates. *Procedia-Social and Behavioral Sciences*, 186, 209-215.

Donnelly, D.F., McGarr, O. & O'Reilly, J. 2014. 'Just Be Quiet and Listen to Exactly What He's Saying': Conceptualising power relations in inquiry-oriented classrooms. *International Journal of Science Education*, 36(12), 2029-2054.

Doyle, W. 1990. Case methods in the education of teachers. *Teacher Education Quarterly*, 7-15.

Duit, R. & Treagust, D.F. 2003. Conceptual change: A powerful framework for improving science teaching and learning. *International journal of science education*, 25(6), 671-688.

Education Act (Lesotho). 2010. *Government Gazette Extraordinary*. Maseru: Government Printer.

Ekici, E. 2016. "Why Do I Slog through the Physics?" Understanding High School Students' Difficulties in Learning Physics. *Journal of Education and Practice*, 7(7), 95-107.

Elfil, M. & Negida, A. 2017. Sampling methods in clinical research; an educational review. *Emergency*, *5*(1).

Etkina, E. 2010. Pedagogical content knowledge and preparation of high school physics teachers. *The American Physical Society,* 6(2), 1-26.

Etkina, E., Gitomer, D., Iaconangelo, C., Phelps, G., Seeley, L. and Vokos, S. 2018. Design of an assessment to probe teachers' content knowledge for teaching: An example from energy in high school physics. *Physical Review Physics Education Research*, *14*(1), 010127.

Farrell, T.S. 2002. Lesson planning. *Methodology in language teaching: An anthology of current practice*, 30-39.

Fernández-Balboa, J.M. & Stiehl, J. 1995. The generic nature of pedagogical content knowledge among college professors. *Teaching and teacher education*, 11(3), 293-306.

Fernández, S. & Figueiras, L. 2014. Horizon Content Knowledge: Shaping MKT for a Continuous Mathematical Education. *Redimat*, 3(1), 7-29.

Fitzgerald, A., & Schneider, K. 2013. What teachers want: Supporting primary school teachers in teaching science. *Teaching science*, 59(2), 7-10.

Friedrichsen, P., Driel, J.H.V. & Abell, S.K. 2011. Taking a closer look at science teaching orientations. *Science Education*, 95(2), 358-376.

Gagne, R.M., Wager, W.W., Golas, K.G. & Keller, J.M. 2005. *Principles of instructional design*. Toronto, ON: Thomson Wadsworth.

Gall, M.D. & Gillett, M. 1980. The discussion method in classroom teaching. *Theory into practice*, 19(2), 98-103.

Gatawa, B. S. M. 1986. *The Zimbabwe Integrated National Teacher Education Course*. Zimbabwe: University of London Institute of Education.

Geeraerts, K., Tynjälä, P. & Heikkinen, H.L. 2018. Inter-generational learning of teachers: what and how do teachers learn from older and younger colleagues? *European Journal of Teacher Education*, *41*(4), 479-495.

Geoff, P. 2014. *Teaching Today: A practical guide.* (5th Ed). Oxford: Oxford University Press.

Gess-Newsome, J. 2015. A model of teacher professional knowledge and skill including PCK: Results of the thinking from the PCK Summit. In *Re-examining pedagogical content knowledge in science education* (pp. 38-52). Routledge.

Gess-Newsome, J. & Lederman, N.G. 1993. Preservice biology teachers' knowledge structures as a function of professional teacher education: A year-long assessment. *Science Education*, 77(1), 25-45.

Ghanaguru, S., Nair, P. & Yong, C. 2017. Teacher trainers' beliefs in microteaching and lesson planning in a teacher training institution. *The English Teacher*, (2), 3.

Ghazi, S. R., Shahzad, G., Shah, M. T. & Shauib, M. 2013. Teacher's professional competences in knowledge of subject matter at secondary level in Southern Districts of Khyber Pakhtunkhwa, Pakistan. *Journal of Education and Social Research*, 3(2), 453-460.

Gillies, R.M. & Boyle, M. 2010. Teachers' reflections on cooperative learning: Issues of implementation. *Teaching and teacher Education*, 26(4), 933-940.

Gillies, R.M. & Nichols, K. 2015. How to support primary teachers' implementation of inquiry: Teachers' reflections on teaching cooperative inquiry-based science. *Research in Science Education*, 45(2),171-191.

Gliem, J. & Gliem, R. 2003. Calculating, interpreting, and reporting Cronbach's Alpha reliability coefficient for Likert-type scales. *In 2003 Midwest research to practice conference in adult, continuing and community education.* Columbus, OH. pp. 82-88.

Godec, S., King, H., Archer, L., Dawnson, E. & Seakins, A. 2018. Examining student engagement with science through Bourdieusian notion of field. *Science & Education*, 27 (5-6), 501-521.

Gosnell, C.L. 2017. Leading with Support: The Role of Social Support for Positive and Negative Events in Leader Development. In *Leader Development Deconstructed* (pp. 275-300). Springer, Cham.

Green, K. H. 2010. Matching Functions and Graphs at Multiple Levels of Bloom's Revised Taxonomy. *PRIMUS: Problems, Resources, and Issues in Mathematics Undergraduate Studies*, (20)3, 204-216.

Greenfader, C.M. & Brouillette, L. 2013. Boosting language skills of English learners through dramatization and movement. *The Reading Teacher*, 67(3), 171-180.

Greenfield, D.B., Jirout, J., Dominguez, X., Greenberg, A., Maier, M. & Fuccillo, J. 2009. Science in the preschool classroom: A programmatic research agenda to improve science readiness. *Early Education and Development,* 20(2), 238-264.

Greenwood, A. 1996. When it comes to teaching about floating and sinking, pre-service elementary teachers do not have to feel as though they are drowning! *Journal of Elementary Science Education*, *8*(1), p.1.

Grossman, P.L. 1990. *The making of a teacher: Teacher knowledge and teacher education*. Teachers College Press: Teachers College, Columbia University.

Grossman, P.L., Wilson, S.M. & Shulman, L.S. 1989. Teachers of substance:

Subject matter knowledge for teaching. *Profesorado, Revista de currículum y formación del profesorado*, 9(2), 1-25.

Guo, Y., Piasta, S. B. & Bowles, R. P. 2015. Exploring preschool children's science content knowledge. *Early Education and Development*, 26, 125-146.

Hadzigeorgiou, Y. 2015. Young children's ideas about physical science concepts. In *Research in early childhood science education* (pp. 67-97). Springer, Dordrecht.

Hair, J., Black, W., Babin, B., Anderson, R. & Tatham, R. 2006. Multivariate data analysis, 6th ed. New Jersey: Prentice Hall.

Hampden-Thompson, G. & Bennett, J. 2013. Science teaching and learning activities and students' engagement in science. *International Journal of Science Education, 35*(8), 1323–1343.

Hammond, Z. 2016. *Culturally responsive teaching and the brain: Promoting authentic engagement and rigor among culturally and linguistically diverse students*. Thousand Oaks, CA: Corwin.

Hardy, I., Jonen, A., Möller, K. & Stern, E. 2006. Effects of instructional support within constructivist learning environments for elementary school students' understanding of" floating and sinking". *Journal of Educational Psychology*, 98(2), 307.

Harlen, W. & Qualter, A. 2014. *The Teaching of science in primary schools*. New York: Routledge.

Harris, J., Mishra, P. & Koehler, M. 2009. Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *Journal of research on technology in education*, 41(4), 393-416.

Harris, C.J. & Rooks, D.L. 2010. Managing inquiry-based science: Challenges in enacting complex science instruction in elementary and middle school classrooms. *Journal of Science Teacher Education*, 21(2), 227-240.

Hashweh, M. Z. 1987. Effects of subject-matter knowledge in the teaching of biology and physics. *Teaching and teacher education,* 3(20), 109-120.

Havu-Nuutinen, S. 2005. Examining young children's conceptual change process in floating and sinking from a social constructivist perspective. *International journal of science education*, 27(3), 259-279.

Hennink, M., Hutter, I. & Bailey, A. 2011. *Qualitative research methods*. Los Angeles: Sage Publications Ltd.

Herbst, P. and Kosko, K. 2012. Mathematical Knowledge for Teaching High School Geometry. *North American Chapter of the International Group for the Psychology of Mathematics Education*.

Hill, H.C., Rowan, B. & Ball, D.L. 2005. Effects of teachers' mathematical knowledge for teaching on student achievement. *American educational research journal*, 42(2), 371-406.

Hill, H.C., Sleep, L., Lewis, J.M. & Ball, D.L. 2007. Assessing teachers' mathematical knowledge. *Second handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics*, *112*.

Hoban, G. F. 2007. Using slow motion to engage pre-service elementary teachers in understanding science content knowledge. *Contemporary Issues in Technology and Teacher Education*, 7(2), 75-91.

Hsin, C.T. & Wu, H.K. 2011. Using scaffolding strategies to promote young children's scientific understandings of floating and sinking. *Journal of Science Education and Technology*, 20(5), 656-666.

Inamullah, H. M., Nasser ud din, M. & Hussain, I. 2008. Teacher-student verbal interaction patterns at the tertiary level of education. *Contemporary Issues in Educational Research*, 1(1), 45-50.

Ireland, J.E., Watters, J.J., Brownlee, J. & Lupton, M. 2012. Elementary teacher's conceptions of inquiry teaching: Messages for teacher development. *Journal of Science Teacher Education*, 23(2), 59-175.

Isaacs, B. 2018. *Understanding the Montessori approach: Early years education in practice*. London: Routledge.

Iserbyt, P., Ward, P. & Li, W. 2017. Effects of improved content knowledge on pedagogical content knowledge and student performance in physical education. *Physical Education and Sport Pedagogy*, *22*(1), 71-88.

Jakobsen, A., Thames, M.H. & Ribeiro, C.M. 2013. Delineating issues related to horizon content knowledge for mathematics teaching. In *Proceedings of the Eight Congress of the European Society for Research in Mathematics Education*. 3125-3124.

James, E. A. 2014. *Writing your Doctoral Dissertation or Thesis Faster*. California: Sage Publications.

Janna, I., Christopher, K., Barbara, S., Kalle, J., Joseph, K., Jari, L. & Katariina, S.A. 2019. Science classroom activities and student situational engagement. *International Journal of Science Education*, *41*(3), 316-329.

Jita, T. 2016. *Pre-service teachers' competences for teaching science through information and communication technologies during teaching practice* (Doctoral dissertation, University of the Free State).

Jiménez-Aleixandre, M.P. & Erduran, S. 2007. Argumentation in science education: An overview. In *Argumentation in science education* (pp. 3-27). Springer, Dordrecht.

Johnson, J. F., Uline, C. & Perez, L. 2011. Expert noticing and principals of high performing urban schools. *Journal of Education for Students Placed at Risk*, 16(2), 122-136.

Johnson, B. and Christensen, L. 2014. *Educational research fourth edition: Quantitative, qualitative and mixed approaches*. USA: Sage Publications.

Joint Board of Teacher Education. 2014. Retrieved from: http://www.jbte.edu.jm/cms/Portals/O/JBTE/Manuals?programme Articulation_and _Structure.pdf.

Justi, R.S. & Gilbert, J.K. 2002. Philosophy of chemistry in university chemical education: The case of models and modelling. *Foundations of Chemistry*, 4(3), 213-240.

Kadbey, H., Dickson, M. & McMinn, M. 2015. Primary teachers' perceived challenges in teaching science in Abu Dhabi public schools. *Procedia-Social and Behavioral Sciences*, 186, 749-757.

Kahan, J., Cooper, D. & Bethea, K. 2003. The role of mathematics teachers' content knowledge in their teaching: A framework for research applied to a study of student teachers. *Journal of Mathematics Teacher Education*, 6(3), 223-252.

Kallery, M. & Psillos, D. 2001. Pre-school Teachers' Content Knowledge in Science: Their understanding of elementary science concepts and of issues raised by children's questions. *International Journal of Early Years Education*, *9*(3), 165-179.

Kavalari, P., Kakana, D, M. & Christidou, V. 2012.Contemporary teaching methods and science content knowledge in preschool education: searching for connections. *Social and Behavioral Sciences,* 46 (2012), 3649-3654.

Kawasaki, K., Herrenkohl, L. & Yeary, S. A. 2004. Theory building and modeling in a sinking and floating unit: A case study of third and fourth grade students' developing epistemologies of science. *International Journal of Science Education*, 26(11), 1299-1324.

Kawulich, B. B. 2005. Participant observation as a data collection method. Forum: *Qualitative Social Research*, 6(2).

Keçeci, G. & Zengin, F.K. 2017. Observing the Technological Pedagogical and Content Knowledge Levels of Science Teacher Candidates. *Educational Research and Reviews*, 12(24), 1178-1187.

Kelly, S. & Tannehill, D. 2012. The mentoring experience of an Irish student teacher on his physical education teaching practicum. *Graduate Journal of Sports, Exercise and Physical Education Research*, 1, 47-64.

Kennedy, M.M. 2002. Knowledge and teaching. *Teachers and Teaching*, 8(3), 355 370.

Kerlinger, F. 1986. *Foundations of behavioral research* (3rd Ed.). New York: Holt, Rinehart, & Winston.

Kessel, C. 2009. *Teaching teachers mathematics: Research, ideas, projects, evaluation*. Mathematical Sciences Research Institute.

Khawaja. I. & Lerche M∅rck, L. 2009. Researcher Positioning: Muslim “Otherness” and beyond. *Qualitative Research in Psychology*, 6:1-2, 28-45.

Kim, J. 2006. The relative influence of research on class size policy. *Brookings*

Papers on Education Policy, 2006(1), 273–295.

Kind, V. 2009. Pedagogical content knowledge in science education: perspectives and potential for progress. *Studies in science education*, 45(2), 169-204.

Kind, V. 2016. Pre-service science teachers' science teaching orientations and beliefs about science. *Science Education*, 100(1), 122-152.

Kinghorn, B.E. 2013. *Gaps in science content knowledge encountered during teaching practice: A Study of early-career middle-school science teachers*. Michigan State University.

Kiray, S. A., Aktan, F., Kaynar, H., Kilinc, S. & Gorkemli, T. 2015. A descriptive study of pre-service science teachers' misconceptions about sinking-floating. In *Asia-Pacific Forum on Science Learning & Teaching*, 16(2).

Koehler, M., Mishra, P. & Cain, W. 2013. What is technological pedagogical content knowledge (TPACK)? *Journal of Education*, 193(3), 14-19.

Lawson, M.A. & Lawson, H.A. 2013. New conceptual frameworks for student engagement research, policy, and practice. *Review of Educational Research*, 83(3), 432-479.

Lazonder, A.W. & Harmsen, R. 2016. Meta-analysis of inquiry-based learning: Effects of guidance. *Review of educational research*, 86(3), 681-718.

Leedy, P. D. & Ormrod, J. E. 2013. *Practical Research Planning and Design*. 10th ed. New York: Pearson.

Lehrer, R., Jaslow, L. and Curtis, C. 2003. Developing an understanding of measurement in the elementary grades. *Learning and teaching measurement*, 1,100-121.

Leinhardt, G. 1983. Novice and expert knowledge of individual student's achievement. *Educational Psychologist*, (18)165-179.

Lemmer, E. M. & Badenhorst, D. C. 1997. *Introduction to Education for South African Teachers.* Kenwyn: Juta.

Lesotho College of Education. 2007. *Curriculum for CECE*. Maseru: Lesotho College of Education.

Lesotho College of Education. 2019. *Teaching practice guidelines.* Maseru:

Lesotho College of Education.

Lesotho College of Education. 2020. *2020-2021 College Calendar.* Maseru: Morija Printing Works.

Leuchter, M., Saalbach, H. & Hardy, I. 2014. Designing Science Learning in the First Years of Schooling. An intervention study with sequenced learning material on the topic of 'floating and sinking'. *International Journal of Science Education*, 36(10). 1751-1771.

Looney, J. 2010. Making it Happen: formative assessment and educational technologies. *Promethean Thinking Deeper Research Papers*, *1*(3), 1-20.

Loyens, S. & Rikers, R. 2011. Instruction based on inquiry. In R. Mayer & P. Alexander (Eds.), *Handbook of research on learning and instruction* (pp. 361–381). New York: Routledge.

Lynd, M. 2005. *Fast-track teacher training: Models for consideration for southern Sudan.* American Institute of Research and the Sudan Basic Education Program.

Maboya, M.J. 2014. *The relationship between teachers' mathematical knowledge and their classroom practices: a case study on the role of manipulatives in South African primary schools* (Doctoral dissertation, University of the Free State).

Mack, L. 2010. Philosophical underpinnings of educational research. *Polyglossia*.

Mages, W.K. 2006. Drama and imagination: a cognitive theory of drama's effect on narrative comprehension and narrative production. *Research in Drama Education*, 11(3), pp.329-340.

Magnusson, S., Krajcik, J. and Borko, H. 1999. Examining pedagogical content knowledge. In Gess-Newsome, J. and Lederman, N. G. (Ed.). *The construct and its implications for science education*. Dordrecht: Kluwer academic Publisher.

Makamure, C. 2016. *Learning to teach secondary school mathematics from practice: An exploration of the Zimbabwean pre-service teachers' year-long field experiences* (Doctoral dissertation, University of the Free State).

Marks, R., 1990. Pedagogical content knowledge: From a mathematical case to a modified conception. *Journal of teacher education*, 41(3), 3-11.

Markworth, K., Goodwin, T. & Glisson, K. 2009. The development of mathematical knowledge for teaching in the student teaching practicum. *AMTE monograph*, 6, 67-83.

Mascolo, M.F. 2009. Beyond student-centered and teacher-centered pedagogy: Teaching and learning as guided participation. *Pedagogy and the Human Sciences*, 1(1), 3-27.

Matšela, Z.A. 1978. *Malito*. Maseru: Mazenod Book Centre.

Mavhunga, M. E. & Rollnick, M. 2011. *The development and validation of a tool for measuring topic specific PCK in Chemical Equilibrium*. In *Proc. ESERA Conf*.

Mayer, R.E. 2004. Should there be a three-strike rule against pure discovery learning? *American psychologist*, 59(1), p.14.

Mayring, P. 2014. *Qualitative content analysis: Theoretical foundation, basic procedures and software solution.* Klagenfurt, Austria: Leibniz-Institute.

McDonald, C.V.& Abd-El-Khalick, F. 2017. Where to from here? Implications and future directions for research on representations of nature of science in school science textbooks. In *Representations of Nature of Science in School Science Textbooks* (215-231). Routledge.

McKee, E., Williamson, V.M. & Ruebush, L.E. 2007. Effects of a demonstration laboratory on student learning. *Journal of Science education and Technology*, 16(5), 395-400.

McMinn, M., Dickson, M. & Kadbey, H. 2015. Emirati Science Teachers' beliefs, Self-Confidence, Challenges Faced, and Their Reported Practice. *International Online Journal Of Primary Education (IOJPE) ISSN: 1300-915X*, *4*(1).

Mercer, N., Dawes, L. and Staarman, J.K. 2009. Dialogic teaching in the primary science classroom. *Language and education*, 23(4), 353-369.

Mertens, D. M. 2010. *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative and mixed methods. 3rd Ed.* UK: Sage.

Mertens, D. M. & Wilson, A. T. 2012. *Program evaluation theory and practice: A comprehensive guide.* New York: The Guilford press.

Michaels, S., Shouse, A. W. & Schweingruber, H. A. 2014. *Ready, set, science! Putting research to work in K-8 science classroom*. Washington D.C.: The National Academic Press.

Ministry of Education and Training (MoET). 2009. *Curriculum and Assessment Policy: Education for individual and social development.* Maseru: BeePee Printers and Stationers.

Ministry of Education and Training (MoET). 2011. *Education Sector Strategic Plan 2005-2015*. Maseru: BeePee Printers and Stationers.

Ministry of Education and Training (MoET). 2011. *Reception Class Guidelines*. Maseru: Ministry of Education and Training.

Ministry of Education and Training (MoET). 2013. *National Policy for Integrated Early Childhood Care and Development*. Maseru: Ministry of Education and Training.

Ministry of Education and Training (MoET). 2014. Educational Statistic Report. *Plan 2005-2015*. Maseru: BeePee Printers and Stationers.

Mishra, P. & Koehler, M.J. 2006. Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108, 1017-1054.

Mogari, D., Kriek, J., Stols, G. & Iheanachor, O. U. 2009. Lesotho’s students’ achievement in mathematics and their teacher’s background and professional development. *Pythagoras,* 70: 3-15.

Morrison, G. S. 2015. *Early Childhood Education Today*. England: Pearson.

Mudulia, A. M. 2012. The relationship between availability of teaching/learning resources and performance in secondary school science subjects in Eldoret Municipality, Kenya. *Journal of Emerging trends in educational research and policy studies*, 3(4), 530-536.

Müürsepp, M. 2013. Age-appropriateness of the scientific vocabulary for beginning readers. *Problems of Education in the 21st Century*, 57, 79-89.

Muwanga-Zake, J.W., 2001. Is science education in a crisis? Some of the problems in South Africa. *Science in Africa*, *2*, 1-14.

Mwamwenda, T.S. 2014. Early childhood education in Africa. *Mediterranean Journal of social sciences*, *5*(20),1403-1403.

National University of Lesotho (NUL). 2020. *Undergraduate Information Booklet 2020/2021*. Maseru: National University of Lesotho (http://www.nul.ls)
Retrived on 21 March 2020.

Nayfeld, I., Brenneman, K. & Gelman, R. 2011. Science in the classroom: Finding a balance between autonomous exploration and teacher-led instruction in preschool settings. *Early Education & Development*, 22(6), 970-988.
Nassaji, H. 2020. Good qualitative research. *Language Teaching Research,* 24(4), 427–431

Nelson, B. G. 2002. The importance of men teachers: And reasons why there are so few. *A survey of members of NAEYC.*

Nketekete, M. & Motebang, M. 2008. Entrepreneurship education in Lesotho secondary schools: Pedagogical challenges. Education, Knowledge and Economy: *A Journal for Education and Social Enterprise*, 2(2), 121-135.

Norlan, A., Macfarlane, K. & Cartmel, J. 2013. *Research in Early Childhood.* London: British Library Cataloguing in Publication data.

Norton, J.P., 2009. *An introduction to identification*. Courier Corporation.

Novilia, L., Iskandar, S. & Fajaroh, F. 2016. The effectiveness of colloid module based on guided inquiry approach to increase students' cognitive learning outcomes. *International Journal of Education*, 9(1), 17-23.

Nowicki, B.L., Sullivan-Watts, B., Shim, M.K., Young, B. & Pockalny, R. 2013. Factors influencing science content accuracy in elementary inquiry science lessons. *Research in Science Education*, 43(3), 1135-1154.

Oh, P. S. & Kim, K. S. 2013. Pedagogical Transformations of Science Content Knowledge in Korean elementary classrooms. *International Journal of Science Education*, 35(9), 1590-1624.

Osanloo, A. & Grant, C. 2016. Understanding, selecting, and integrating a theoretical framework in dissertation research: Creating the blueprint for your “house”. *Administrative issues journal: connecting education, practice, and research*, 4(2),1-15.

Osborne, J., Collins, S. Ratcliffe, M., Millar, R. & Duschl, R. 2003. What “ideas-about science” should be taught in school science? A Delphi study of the expert community. *Journal of Research in Science Teaching*, 40(7), 692-720.

Osborne, J. & Simon, S. 1996. Primary science: past and future directions. *Studies in Science Education*, 27:1, 99-147

Osher, D., Cantor, P., Berg, J., Steyer, L. and Rose, T. 2020. Drivers of human development: How relationships and context shape learning and development1. *Applied Developmental Science*, *24*(1), 6-36.

Paik, S. H., Song, G., Kim, S. & Ha. 2017. Developing a four-level learning progression and assessment for concept of Buoyancy*. EURASIA Journal of Mathematics Science and Technology Education*, 13(8), 4965-4986.

Palaiologou, L. 2016. *The early years foundation stage: theory and practice.* 3rd ed.London: Sage.

Palmer, D., Dixon, J. & Archer, J. 2015. Changes in Science Teaching Self-Efficacy among Primary Teacher Education Students. *Australian Journal of Teacher Education*, 40(12), 25 - 40.

Pennings, H. J. and Hollenstein, T. 2020. Teacher-student interactions and teacher interpersonal styles: A state space grid analysis. *The Journal of Experimental Education*, *88*(3), 382-406.

Phellas, C. N., Bloch, A. & Seale, C. 2011. Structured method: Interviews, questionnaires and observation. In C. Seale (Ed.) *Researching society and culture*, third edition. London: Sage Publications. pp. 181-205.

Piaget, J. 1962. *Comments on Vygotsky's critical remarks concerning. The language and Thought of the Child, and Judgment and Reasoning in the Child*. MIT Press.

Piaget, J. 2001. *Studies in Reflecting Abstraction*. Hove, UK: Psychology Press.

Piccioli, M. 2019. Educational research and Mixed Methods. Research designs, application perspectives, and food for thought. *Studi sulla Formazione/Open Journal of Education*, *22*(2), pp.439-450.

Plano Clark V.L. & Creswell J.W. 2014. *Understanding Research*. *A Consumer's Guide*. Pearson Higher Ed, 2nd ed.

Rabaza, M. 2016. *The relationship between Grade 9 mathematics teachers' content knowledge and their learners' understanding of linear graphs*. Unpublished dissertation. Mthatha: Walter Sisulu University.

Råheim, M., Magnussen, L.H., Sekse, R.J.T., Lunde, Å., Jacobsen, T. and Blystad, A. 2016. Researcher–researched relationship in qualitative research: Shifts in positions and researcher vulnerability. *International journal of qualitative studies on health and well-being*, *11*(1), 30996.

Ramnarain, U. & Fortus, D. 2013. South African physical sciences teachers' perceptions of new content in a revised curriculum. *South African journal of education*, 33(1), 1-15.

Raselimo, M. 2010. *Curriculum reform in Lesotho: Exploring the interface between environmental education and geography in selected schools*. (PhD thesis). Grahamstown: Rhodes University.

Reed, D.K. 2012. Clearly communicating the learning objective matters! Clearly communicating lesson objectives supports student learning and positive behavior. *Middle School Journal*, 43(5), 16-24.

Rice, A. H. & Kitchel, T. 2017. Teachers' beliefs about the purpose of Agricultural Education and its influence on their pedagogical content knowledge. *Journal of Agricultural Education*, 58(2).

Robertson, A.D., Scherr, R.E., Goodhew, L.M., Daane, A.R., Gray, K.E. & Aker, L.B. 2017. Identifying content knowledge for teaching energy: Examples from high school physics. *Physical Review Physics Education Research*, 13(1), 010105.

Robison, E. S. 2017. *Science Content Knowledge: A Component of Teacher Effectiveness in a Primary School in Jamaica*. Jamaica: Walden University.

Rubin, A. & Babbie, E. 2010. *Research methods for social work*. *7th Ed*. USA: Cengage.

Russell-Bowie, D.E. 2012. Developing pre-service primary teachers' confidence and competence in arts education using principles of authentic learning. *Australian Journal of Teacher Education*, 37(1), 60-74.

Saçkes, M. 2014. How often do early childhood teachers teach science concepts? Determinants of the frequency of science teaching in kindergarten. *European early childhood education research journal*, 22(2), 169-184.

Saçkes, M., Trundle, K. C., Bell, R. L. & O'Connell, A. A. 2011. The influence of early science experience in kindergarten on children's immediate and later science achievement: Evidence from the early childhood longitudinal study. *Journal of Research in Science Teaching*, 48(2), 217-235.

Sadler, P. M., Sonnert, G., Coyle, H. P., Cook-Smith, N. & Miller, J. L. 2013. The influence of teachers' knowledge on student learning in middle school physical science classrooms. *American Educational Research Journal*. p.0002831213477680.

Santagata, R., Zannoni, C. & Stigler, J.W. 2007. The role of lesson analysis in pre-service teacher education: An empirical investigation of teacher learning from a virtual video-based field experience. *Journal of mathematics teacher education*, 10(2), 123-140.

Schmidt, W. H, Cogan, L. & Houang, R. 2011. The Role of Opportunity to Learn in Teacher Preparation: An International Context. *Journal of Teacher Education*, 62(2), 138-153.

Schreurs, J. & Dumbraveanu, R. 2014. A shift from teacher centered to learner centered approach. *International Journal of Engineering Pedagogy (iJEP)*, 4(3), 36-41.

Sebatane, E. M. & Lefoka, J. P. 2004. *Evaluation of the Home-Based Programme*. Unpublished Consultancy Report. Maseru: Ministry of Education and Training.

Setoromo, M., Bansilal, S. & James, A. 2020. Lesotho Grade R teachers' mathematical knowledge for teaching numeracy. *South African Journal of Childhood Education*, 8(2), 1-9.

Shulman, L.S. 1986. Those who understand: Knowledge growth in teaching. *Educational researcher*, 15(2), 4-14.

Shulman, L.S. 1987. Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review,* 57(1), 1-21.

Shulman, L.S. 2003. *A different way to think about teaching and learning. Learning to teach: Sharing the Wisdom of Practice. The Carnegie Foundation for the Advancement of Teaching*. SAGE publications.

Setiawan and Siayah. 2020. A Brief Explanation of Science Education.

Silverman, D. 2011. *Qualitative research, 3rd ed*. London: Sage Publications.

Smith, D.C. & Neale, D.C. 1989. The construction of subject matter knowledge in primary science teaching. *Teaching and teacher Education*, 5(1), 1-20.

Smith, C., Carey, S. and Wiser, M. 1985. On differentiation: A case study of the development of the concepts of size, weight, and density. *Cognition*, *21*(3), 177-237.

Södervik, I., Mikkilä-Erdmann, M. & Vilppu, H. 2014. Promoting the understanding of photosynthesis among elementary school student teachers through text design. *Journal of Science Teacher Education*, 25(5), 581-600.

Spaull, N. 2013. *South Africa's education crisis: The quality of education in South Africa 1994 – 2011.* Report Commissioned by Centre for Development and Enterprise. Johannesburg.

Statistical Analysis Software (SAS). 2017. *SAS/STAT14.3 User's Guide*. Cary, NC: SAS Institute Inc.

Staver, J.R. 2007. Teaching Science. Educational Practice Series 17, *International Academy of Education, Australia……….*

Stigler, J. W., Gallimore, R. & Hietbert, J. 2010. Using Video Survers to Compare Classrooms and Teaching Across Cultures: Examples and Lessons from the TIMSS Video Studies. *Educational Psychologist*, 35(2), 87-100.

Sun, D., Wang, Z.H., Xie, W.T. & Boon, C.C. 2014. Status of integrated science instruction in junior secondary schools of China: An exploratory study. *International Journal of Science Education*, 36(5), 808-838.

Sun, M., Loeb, S. & Grissom, J.A. 2017. Building teacher teams: Evidence of positive spillovers from more effective colleagues. *Educational Evaluation and Policy Analysis*, *39*(1), pp.104-125.

Tairab, H. 2010. Assessing science teachers' content knowledge and confidence in teaching science: how confident are UAE prospective elementary science teachers? *International Journal of Applied Educational Studies*, *7*(1).

Tamir, P. 1988. Subject matter and related pedagogical knowledge in teacher education. *Teaching and teacher education*, 4(2), 99-110.

Tavakol, M. & Dennick, R. 2011. Making sense of Cronbach's alpha. *International Journal of Medical Education*, 2, 53-55.

Taylor, D.L. & Booth, S. 2015. Secondary physical science teachers' conceptions of science teaching in a context of change. *International Journal of Science Education*, 37(8), 1299-1320.

Teddlie, C. & Tashakkori, A. 2009. *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*. Sage.

Thornbury, S. 1999. *How to teach grammar* (Vol. 3). Harlow: Longman.

Tomlinson, C. 2014. Differentiating instruction for academic diversity. In: J. Cooper.

Classroom teaching skills. Belmont, CA: Wadsworth Cengage Learning.

Tracy, S. J. 2013. *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. UK: John Wiley & Sons.

Trends in International Mathematics and Science Study (TIMSS). 2015. *Teacher Questionnaire*. Washington DC: Pearson.

Trundle, K. C. & Sackes, M. 2012. Science and early education. In R. C. Pianta, W. S. Barnett, L. M. Justice, & S. M. Sheridan (Eds.), *Handbook of early childhood education* (pp. 240–258). New York, NY: Guilford Press.

Unal, S. 2008. Changing students' misconceptions of floating and sinking using hands-on activities. *Journal of Baltic Science Education*, 7(3), 134-146.

UNESCO. 2014a. *Education For All Global Monitoring Report 2013/4 – Teaching and learning: Achieving quality for all*. UNESCO Publishing.

Utz, A. & Aubert, J. E. 2008. Fostering innovation, productivity and technology change. In R. J. Utz (ed.), *Sustaining and sharing economic growth in Tanzania*. Washington D.C.: The World Bank.

Van Driel, J.H., Jong, O.D. & Verloop, N. 2002. The development of pre-service chemistry teachers' pedagogical content knowledge. *Science Education*, 86(4), 572-590.

Van Driel, J.H., Verloop, N. & De Vos, W. 1998. Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 35(6), 673-695.

Vokos, S., Gitomer, D., Dias, C., Etkina, E., Minstrell, J. & Seeley, L. 2014. Developing, validating, and measuring Content Knowledge for Teaching: an example from physics. In *iste international conference on mathematics, science and technology education* (p. 37).

Vosniadou, S. 2007. Conceptual change and education. *Human development*, 50(1), 47-54.

Ward, P. 2009. Content matters: Knowledge that alters teaching. *Historic traditions and future directions of research on teaching and teacher education in physical education*, 345-356.

Wilson, S.M. & Wineburg, S.S. 1988. Peering at History through Different Lenses: The Role of Disciplinary Perspectives in Teaching History. *Teachers College Record*, 89(4), 525-39.

Yin, R. K. 2014. *Case study research: Design and methods*. London: Sage.

Yin, Y., Tomita, M.K. & Shavelson, R. J. 2008. Diagnosing and dealing with student misconceptions: Floating and sinking. *Science scope*, 31(8), 34.

Yin, Y., Tomita, M.K. & Shavelson, R. J. 2014. Using formal embedded formative assessments aligned with a short-term learning progression to promote conceptual change and achievement in science. *International Journal of Science Education*, 36(4), 531-552.

Yusof, S. M., Alrazi, A., Tahir, L. M., Naim, H. A., Talib, R. & Samah, N. A. 2016. The singing method in teaching and learning process in helping students to master Arabic lexical. *Man In India*, 96(1-2), 79-91.

Zambak, V.S. & Tyminski, A.M. 2017. A Case Study on Specialised Content Knowledge Development with Dynamic Geometry Software: The Analysis of Influential Factors and Technology Beliefs of Three Pre-Service Middle Grades Mathematics Teachers. *Mathematics Teacher Education and Development*, 19(1), 82-106.

Zhang, Y. & Wildemuth, B.M. 2009. Qualitative analysis of content. *Applications of social research methods to questions in information and library science*, 308, p.319.

Zoupidis, A., Pnevmatikos, D., Spyrtou, A. & Kariotoglou, P. 2016. The impact of procedural and epistemological knowledge on conceptual understanding: the case of density and floating–sinking phenomena. *Instructional Science*, 44(4), 315-334.

Zuckerman, G., Chudinova, E., & Khavkin, E. 1998. Inquiry as a pivotal element of knowledge acquisition within Vygotskian paradigm: Building a science curriculum for the elementary school. *Cognition and Instruction.* 16, 201-233.

Appendix A: Questionnaire

Dear Teacher

Kindly complete this questionnaire fully.

The questionnaire is strictly for research purposes. As a result, your anonymity is guaranteed as you do not have to give your name. Please be honest and accurate. All information will be treated in strict confidence. Your cell number will be needed as you might be contacted for interview and classroom observation. **Cell Number ……………………………….**

Answer the following questions by ticking one appropriate answer in each item.

SECTION A: PERSONAL INFORMATION

1. Gender

(a)	Male	
(b)	Female	

2. Age (in years)

(a)	20 – 29	
(b)	30 – 39	
(c)	40 – 49	
(d)	50 – 59	

3. Teaching experience (number of years)

(a)	1 – 5	
(b)	6 – 10	
(c)	11 – 15	
(d)	16 and above	

4. Highest level of education

(a)	Certificate in Early Childhood Education	
(b)	Other (Please specify) ……………………………………………………………	

Select and rank your choice of response by placing an "X" in the box provided:

1-Strongly Disagree (SD), 2–Disagree (D), 3-Neutral (N), 4–Agree (A) and 5-Strongly Agree (SA).

SECTION B: TEACHERS' PERCEIVED COMMON CONTENT KNOWLEDGE ON SCIENCE CONCEPTS

In the boxes below, tick whether you Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A) and Strongly Agree (SD) with the statement.

Item		SD	D	N	A	SA
5	I have enough knowledge about science concepts such as floating and sinking.					
6	I can comfortably plan the concepts floating and sinking to teach Grade R learners.					
7	Concepts such as floating and sinking do not require little content knowledge.					
8	Teachers' little science content knowledge does not limit delivery of science concepts.					
9	If one is well-informed in science he or she can implement activities easily.					
10	Knowledge of science content involves facts.					
11	Knowledge of science content involves step-by-step process.					
12	Knowledge of science content involves science skills.					
13	I can communicate steps in science experiments as required.					
14	I am comfortable to answer Grade R learners' questions on science.					
15	The experience I have in teaching helps me to understand science concepts.					
16	I rely on textbooks to understand science concepts.					
17	I rely on curriculum guide to understand science concepts.					
18	I consult my colleagues to clarify science concepts I do not know.					
19	The tertiary education exposed me to science concepts.					
20	High school education exposed me to science concepts.					
21	Science textbooks exposed me to science concepts.					
22	I took science as a specialised course at the college.					
23	I took science as a general course at the college.					

SECTION C: TEACHERS' PERCEIVED SPECIALISED CONTENT KNOWLEDGE ON FLOATING AND SINKING In the boxes below, tick whether you Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A) and Strongly Agree (SD) with the statement.						
Item		**SD**	**D**	**N**	**A**	**SA**
24	Things float if they are 'supported by water' (or air) due to an upward force.					
25	A fish can be said to be floating in water even if it is not on the surface.					
26	A nail will sink in water even if its weight can be smaller than a log.					
27	Light objects float regardless of their size, shape or the type of material used to make them.					
28	Clay that is shaped like a plate will sink in water.					
29	A ball like clay will sink in water.					
30	A true floating object must be completely above the surface of the liquid.					
31	All objects that float must contain some trapped air.					
32	One will feel an up-thrust force while dipping a ball in water.					
33	Many stones on a tray will sink in water.					
SECTION D: TEACHERS' PERCEIVED HORIZONTAL CONTENT KNOWLEDGE In the boxes below, tick whether you Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A) and Strongly Agree (SD) with the statement.						
Item		**SD**	**D**	**N**	**A**	**SA**
34	I engage literature to teach floating and sinking.					
35	I interact technology while teaching floating and sinking.					
36	I relate floating and sinking to everyday life.					
37	I integrate numeracy while teaching the topic floating and sinking.					
38	I ask learners to draw what they observed while doing floating and sinking activity.					
39	I create opportunities for learners to engage in play activities to emphasise the concept "floating and sinking"					
40	There should be a spiral relationship of science concepts taught in early childhood to high school.					

41	Playing with water by preschool learners serves as a foundation for floating and sinking objects.					
42	Preschool learners will understand the concept of density when they are in higher grades.					
43	Preschool learners will know the force that pushes objects to float when they are in higher grades.					
SECTION E: Teacher-oriented classroom practice (tick whether you Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A) and Strongly Agree (SD) with the statement) Adopted from Baeten et al. (2013), TIMSS Questionnaire (2015) and Horizon Research, INC questionnaire (2012)						
Item		**SD**	**D**	**N**	**A**	**S A**
44	I tell my learners the concept floating and sinking.					
45	I do not interact with my learners while teaching them about the topic floating and sinking.					
46	I expect my learners to accept the ideas that I provide them on the topic floating and sinking.					
47	I prefer that my learners hold their personal opinion during classroom experiences.					
48	I only provide examples of floating and sinking objects as described in the curriculum guide.					
49	I explain the steps to follow when doing activities with learners.					
50	I look at the activities from the book.					
51	I bring objects that can float and sink in the classroom.					
52	I ask questions that establish learners' previous knowledge.					
53	I demonstrate floating and sinking concepts to the learners.					
54	I predict for the learners the objects that will float or sink when teaching the concepts of floating and sinking.					
55	I write learners' predictions about things that float and the ones that sink in water.					
56	I can see learners' common errors while classifying floating and sinking objects					
57	I classify objects that float and objects that sink in water.					
58	I record observed objects.					
59	I can assist learners to identify connections between floating and sinking.					
60	I ask learners questions on the work done.					

61	I give learners homework on the work done					
62	I ask learners to work individually.					
63	I give feedback and conclude the lesson.					
SECTION F: Learner-oriented classroom practice (tick whether you Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A) and Strongly Agree (SD) with the statement)						
Item		**SD**	**D**	**N**	**A**	**S A**
64	I encourage learners to tell me things that float or sink first.					
65	I encourage learners to bring objects that can float and sink in the classroom.					
66	I encourage learners to think about objects that will float or sink when teaching the concepts "floating and sinking".					
67	I encourage learners to classify objects that float and objects that sink in water.					
68	I encourage learners to carry out activities of floating and sinking objects.					
69	I encourage learners to record observed floating and sinking objects by drawing.					
70	I encourage learners to assess the work done by others after recording.					
71	I ask learners to work in pairs or small groups.					
72	I give learners chance to explain their answers.					
73	I ask learners to record their findings.					
74	Learners are given chance to observe each other while doing activities.					

Appendix B: Interview schedule

Semi- structured Interview questions

Pre-observation interview

Background related

1. Tell me a little bit about yourself.
2. How long have you been teaching?
3. Which school did you do your Form E? Is it in the rural, urban or semi-urban?
4. Do you think your high school gave you enough exposure to science concepts?
5. Did you do Biology, Chemistry or Physics in high school? What about in secondary school?
6. How has your college education prepared you for teaching science?
    a) What was your related course?
    b) How long have you done the course?
7. How were you introduced to teaching of the sub-theme *floating* and *sinking*?
    a) Do you belief you understood the concepts?
    b) If “yes”, explain how you understood that concepts.
    c) If “no”, explain the challenges you encountered.
    d) How did you solve them?

Classroom Related

8. Which materials are appropriate to teach the sub-theme *floating* and *sinking*?
    a) How will you help learners use the materials?
    b) Do you bring materials yourself or you ask learners?

9. While teaching the sub-theme floating and sinking, what pre-requisite knowledge will you require from learners?
10. From which theme are the concepts of floating and sinking derived?
11. How do you introduce the sub-theme to the learners?
12. What activities do you do to achieve your planned objectives?
13. What form of assessment do you engage to assess learners' understanding of the sub-theme *floating* and *sinking*?
14. Do you give learners chance to assess their work?
    a) If "yes". Explain how you let them do that.

Content knowledge related

15. Please explain to me your understanding of the concepts floating and sinking.
16. Everything that is put in water displaces water. What causes that displacement?
17. Explain what causes objects to float or sink. (i.e. what are the forces (Upthrust/buoyancy) involved in floating, arrangement of particles, density)
18. Can you explain why objects made from the same material e.g. a metal spoon and a ship will sink and the other will float?
19. What scientific skills or processes do you engage in teaching learners floating and sinking? Is there any logical explanation you can give in doing those strategies?
20. Can you clarify for me the concepts learners will learn in upper grades that are related to floating and sinking.
21. While teaching floating and sinking, what other learning areas can you incorporate that will emphasise the concepts "floating and sinking"? Elaborate

Thank you

Post-observation interview

22. Was there any form of reference you used to guide your lesson presentations?

If yes, what was it?

23. Was your lesson presentation understood by the learners? Please explain if “yes” or “no”.
24. Can you say your approach was teacher-oriented, learner-oriented or both. Explain your answer.
25. What are the challenges of teaching floating and sinking?
26. Suggest how teachers’ knowledge of floating and sinking could be improved.

Thank you

Appendix C: Classroom observation

Observation Schedule

Objectives are: • Clearly stated such that are specific, measurable, achievable, realistic and time-bound. • In line with the sub-theme (floating and sinking)	
Introduction: • Capture learners' attention • Is related to the sub-theme (floating and sinking) • Connects new knowledge with prior knowledge	
Teaching and Learning Materials • Appropriate • Effectively used • Manipulated by learners	
Teaching methods and strategies • Appropriate • Teacher explains terms /concepts/procedures well for learners to do experiential learning • Teacher integrates other areas of learning • Teacher involves learners • Teacher corrects learners' mistakes • Teacher guides learners well with probing questions	
Activities • Are planned in a sequential manner • Address objective (s) • Teacher-oriented or learner-oriented	
Content • Accurate • In line with objectives • At the level of the learners	
Assessment • In line with lesson objective (s) • Appropriate • Targets skills that were intended to be developed	

• All learners were given chance to practice • Variety of assessment methods used to meet different learning styles • Teacher-oriented or learner-oriented	
Conclusion • Main points of the lesson were emphasized • Objectives covered	

Appendix D: Lesson plan grid analysis tool

Lesson plan	Comments
Lesson objectives (objectives are SMART)	
Requirement of learners' previous knowledge Connects new knowledge with prior knowledge	
Introduction Relevant and activates learners interest,	
Materials Age appropriate and relevant	
Teaching strategies/pedagogy Learner-oriented	
Activities (includes scientific skills) relevant to the content guiding to achieve the stated objectives	
Assessment Relates to lesson objective	
Conclusion Emphasises the main points of the lesson	

Appendix E1: Ethical Clearance letter 1

UFS·UV

[redacted]

Faculty of Education

27-Aug-2017

Dear **Mrs Lintle Maraisane**

Ethics Clearance: **The influence of Lesotho grade R teachers' science content knowledge on their classroom practices**

Principal Investigator: **Mrs Lintle Maraisane**

Department: **School of Education Studies (Bloemfontein Campus)**

APPLICATION APPROVED

With reference to you application for ethical clearance with the Faculty of Education, I am pleased to inform you on behalf of the Ethics Board of the faculty that you have been granted ethical clearance for your research.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2017/1015**

This ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the ethics office to ensure we are kept up to date with your progress and any ethical implications that may arise.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours faithfully

Prof. MM Mokhele
Chairperson: Ethics Committee

Education Ethics Committee
Office of the Dean: Education
T: +27 (0)51 401 9683| F: +27 (0)86 546 1113 | E: NkoaneMM@ufs.ac.za
Winkie Direko Building | P.O. Box/Posbus 339 | Bloemfontein 9300 | South Africa
www.ufs.ac.za

Appendix E2: Ethical Clearance letter 2 (extension)

UFS·UV

[redacted]

Faculty of Education

16-Oct-2018

Dear **Ms Maraisane**

Ethics Clearance: **The influence of Lesotho grade R teachers' science content knowledge on their classroom practices**

Principal Investigator: **Ms Mamontsuoe Maraisane**

Department: **School of Education Studies Department (Bloemfontein Campus)**

APPLICATION FOR EXTENSION APPROVED

With reference to your application for extension for ethical clearance with the Faculty of Education, I am pleased to inform you on behalf of the Research Ethics Committee of the faculty that you have been granted extension from **to** with the assumption that there are no major changes with regards to the study.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2017/1015**

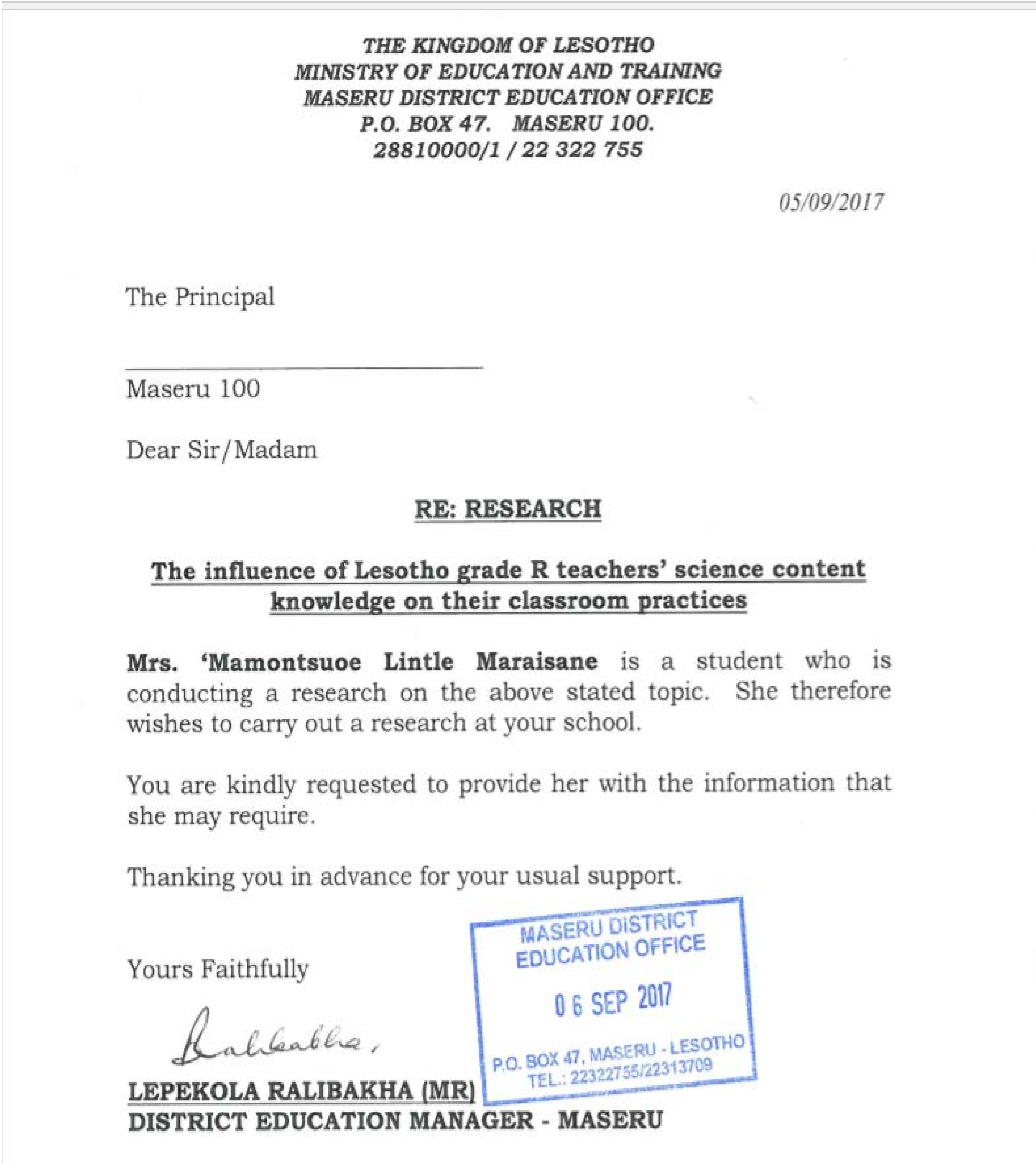
Should you require more time to complete this research, please apply for an extension again.

We request that any changes that may take place during the course of your research project be submitted to the ethics office to ensure we are kept up to date with your progress and any ethical implications that may arise.

Thank you for submitting the application for extension. We wish you every success with your research.

Yours faithfully

Appendix F: Permission to conduct a research by Ministry of Education



THE KINGDOM OF LESOTHO
MINISTRY OF EDUCATION AND TRAINING
MASERU DISTRICT EDUCATION OFFICE
P.O. BOX 47. MASERU 100.
28810000/1 / 22 322 755

05/09/2017

The Principal

____
Maseru 100

Dear Sir/Madam

RE: RESEARCH

The influence of Lesotho grade R teachers' science content knowledge on their classroom practices

Mrs. 'Mamontsuoe Lintle Maraisane is a student who is conducting a research on the above stated topic. She therefore wishes to carry out a research at your school.

You are kindly requested to provide her with the information that she may require.

Thanking you in advance for your usual support.

Yours Faithfully

MASERU DISTRICT
EDUCATION OFFICE
06 SEP 2017
P.O. BOX 47, MASERU - LESOTHO
TEL.: 22322755/22313709

LEPEKOLA RALIBAKHA (MR)
DISTRICT EDUCATION MANAGER - MASERU

Appendix G: Principal's letter asking for permission to conduct a research

P. O. Box 15573
Maseru 100
Lesotho

12 September 2017

The Principal

Maseru 100
Lesotho

Dear Sir/Madam

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I hereby request permission to conduct research at your school. My name is Mamontsuoe Lintle Maraisane, a PhD student at the University of the Free State. I am also a lecturer at the Lesotho College of Education. As part of my Doctoral programme, I am requested to conduct a research on the topic that will contribute to knowledge and understanding of issues under the study. The title of my research is: ***The influence of Lesotho Grade R teachers' science content knowledge on their classroom practices***

The purpose of the study is to explore the influence of Lesotho's Grade R teachers' science content knowledge on their classroom practices. An understanding of how science content knowledge shape Grade R teachers' classroom practices will assist researchers with practices and beliefs and attitudes of preschool teachers when teaching science. This study will inform institutions training preschool teachers on science concepts and the way they should improve their practices. The findings will inform curriculum designers to strengthen areas that will contribute to teaching of science.

A Grade R teacher in your school will respond to a questionnaire. The teacher may be selected in follow-up classroom observations and semi-structured interviews and his or her lesson plans will be photocopied and analysed on science concepts. This follow-up selection will be based on simple random sampling with the aim of covering a sample representation of Maseru urban, Maseru semi-urban and Maseru rural. A minimum of three to a maximum of five classroom observations will be carried out during teaching and learning. Follow-up interviews will be done after school. Each of the interviews and observations completion is expected to last between twenty and thirty minutes. Please take note that audio and video recordings could be carried if need be.

I guarantee that the information gathered will be used for the purpose of this research only. Information will be kept safely in a locked place and destroyed after five years.

I undertake to observe confidentiality and to protect participants from physical, social and/or psychological harm. No names of the schools and/or persons shall be used in any reports of the research. All participants will be asked to participate voluntarily in the study and may withdraw at any time should they wish so.

Upon the completion of the study, I undertake to provide the Ministry of Education and Training with a copy of the research report and share my findings with the schools that will take part in this study.

For further information regarding this research you may contact; my supervisor Professor Loyiso C. Jita at jitalc@ufs.ac.za or +27514017522 at the University of the Free State or myself Mrs. Mamontsuoe Lintle Maraisane: (+266) 58411251 or lintlemj@gmail.com.

Thank you in advance for consideration of my request.

Yours sincerely

…………………………………

Mamontsuoe Lintle Maraisane

Appendix H: Consent to participate in a research

P. O. Box 15573
Maseru 100
Lesotho

Dear Participant

INVITATION TO PARTICIPATE IN RESEARCH STUDY ON "GRADE R TEACHERS' SCIENCE CONTENT KNOWLEDGE AND CLASSROOM PRACTICES"

I hereby invite you to participate in my research study on "Grade R teachers' science content knowledge and classroom practices". My name is Mamontsuoe Lintle Maraisane, a PhD student at the University of the Free State. I am also a lecturer at the Lesotho College of Education. As part of my Doctoral programme, I am requested to conduct a research on the topic that will contribute to knowledge and understanding of issues under the study. The title of my research is:

The influence of Lesotho Grade R teachers' science content knowledge on their classroom practices

The purpose of the study is to explore the influence of Lesotho's Grade R teachers' science content knowledge on their classroom practices. An understanding of how science content knowledge shape Grade R teachers' classroom practices will assist researchers with practices and beliefs and attitudes of preschool teachers when teaching science. This study will inform institutions training preschool teachers on science concepts and the way they should improve their practices. The findings will inform curriculum designers to strengthen areas that will contribute to teaching of science.

You will respond to a questionnaire which will require your science content knowledge and your classroom practices. You may be selected in follow-up classroom observations and semi-structured interviews and your lesson plan will be photocopied and analysed on science concepts. A follow-up selection will be based on simple random sampling with the aim of covering a sample representation of Maseru urban, Maseru semi-urban and Maseru rural. A minimum of three to a maximum of five classroom observations will be carried out during teaching and learning. Follow-up interviews will be done after school. Each of the interviews and observations completion is expected to last between twenty and thirty minutes. Please take note that audio and video recordings could be carried if need be.

I guarantee that the information gathered will be used for the purpose of this research only. Information will be kept safely in a locked place and destroyed after five years.

I undertake to observe confidentiality and to protect participants from physical, social and/or psychological harm. No names of the schools and/or persons shall be used in any reports of the research. All participants will be asked to participate voluntarily in the study and may withdraw at any time should they wish so

Upon the completion of the study, I undertake to provide the Ministry of Education and Training with a copy of the research report and share my findings with the schools that will take part in this study.

For further information regarding this research you may contact; my supervisor Professor Loyiso C. Jita at jitalc@ufs.ac.za or +27514017522 at the University of the Free State or myself Mrs. Mamontsuoe Lintle Maraisane: (+266) 58411251 or lintlemj@gmail.com.

Thank you in advance for consideration of my request.

Yours sincerely

Mamontsuoe Lintle Maraisane

If you agree to participate in the research study entitled:

The influence of Lesotho Grade R teachers' science content knowledge on their classroom practices

Please complete the attached consent form

- I agree to take part in this study.
- I have read and understood the accompanying letter and know what the study is about and the part I will be involved in.
- I understand what the potential benefits and risks are.
- I know that I can decide not to continue with this research at any time.
- I give the researcher permission to make use of the information collected from my participation, for research purposes only.

Participant

Name: ________________________________ Signature:__________________

Date:___________________________

Researcher

Name: ________________________________ Signature:__________________

Date:___________________________

Appendix H: Language editing

Acknowledgment of Language Editing

Date: Thursday, 29 October 2020

This is to certify that I have conducted Language Editing on the following:

THE INFLUENCE OF LESOTHO GRADE R TEACHERS' SCIENCE CONTENT KNOWLEDGE ON THEIR CLASSROOM PRACTICES

by:

MAMONTSUOE LINTLE MARAISANE

(MOLONGOANA)

Algraham

Andrew Graham (BA, MA dist., PhD, University of Keele, UK)*

Telephone: 011 475 6724

Email: happy4andrew@hotmail.com

*Former Tutor in Postgraduate Writing Centre and Managing Editor of ISI Accredited Journal

Appendix J: Turnitin Report

Turnitin Originality Report

Processed on: 10-Nov-2020 12:00 SAST
ID: 1382760794
Word Count: 62886
Submitted: 4

The influence of grade R teachers' science content knowledge on their classroom practices By Mamontsuoe Maraisane

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