Teaching Methods in Science Education in Finland and Namibia

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Autumn 2018
This study compares the teaching methods in science education in Finland and Namibia to understand the preferred teaching methods in both educational systems and the reasons underlying these preferences. It focuses on the preferred teaching methods of selected middle school science teachers of Biology/Life science, Geography, and Physical science (Chemistry and Physics). The study employs a case-based cross-national comparative approach, which investigates the nature of pedagogical practices as a set of human actions that are intentionally organised towards the transmission of a socially legitimated culture. Four schools were selected where three schools were in Namibia and one school in Finland. From the selected schools, eight middle school science teachers from each country were interviewed.

The study takes a broader view of the classification of the teaching methods, which are grouped into six categories. These categories include experimental, small-group working, resource-based learning, creative problem solving, out of school informal learning and teacher-led large groups teaching methods.

The main findings of this study are that Finnish science teachers tend to apply the use of experimental teaching methods more while Namibian science teachers tend to apply the use of small group working methods more. Because the experimentation methods require laboratory equipment, the differences in approach in the Namibian context are due to limited resources. In Finland on the other hand, the popularity of the experimental teaching methods can be explained mainly in reference to the availability of science teaching resources. In the Namibian context, the reliance primarily on the small working methods deprives learners of the opportunity to acquire some scientific skills that come with experimental activities. In light of these implications, science teaching in Namibia requires the government to invest more resources in middle schools that would enable teachers to use a variety of teaching methods. Finnish Middle school science teachers, on the other hand, must include teaching methods that involve more learner interaction and participation like small-group working.

Avainsanat – Keywords: Science education; teaching approaches; teaching methods; teaching science.
DEDICATION

This thesis is dedicated to my parents:
Beauty Mwendalubi Namongwe-Katukula (Mother)
Charles Kamwi Katukula (Father)
Who the desire of making them happy, had always been my strength in academic life and achievements.
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1. Introduction of the study

This study compares the teaching methods used by the middle school science teachers in Finland and Namibia. It focuses on the preferred teaching methods of selected middle school science teachers of Biology/Life science, Geography, and Physical science (Chemistry and Physics). In Finnish lower secondary school (middle school), five subjects namely: Biology, Chemistry, Geography, Health education and Physics makes science education. In Namibia, lower secondary (junior secondary) three subjects namely: Agricultural science, Life science and Physical science make science education. Life science incorporates health education and proceeds to be Biology in senior secondary while Physical science is a combination of (Chemistry and Physics). The study takes a broader view of the classification of the teaching methods as indicated by the respondents, which are grouped into six categories. These are experimental, small-group working, resource-based learning, creative problem solving, out of school informal learning and teacher-led large groups teaching methods.

After a brief analysis of the main concepts used in this study, discourses relating to the major approaches applicable to teaching generally, and to teaching science specifically have been outlined. The approaches include the learner-centred approach and the teacher-centred approach. As shall be demonstrated, disagreements exist on which of the two approaches of teaching is more effective. Most commentators favour the learner-centred approach. This preference is mainly due to the perception that it allows learners to construct new knowledge with minimal guidance from the teacher. On this view, the knowledge thus constructed becomes more meaningful to learners because it allows them to learn by doing. The teacher-centred approach is less preferred because it presumes that teachers are the ones that possess all the knowledge that learners need and all they need to do is to transmit it to them. According to critics, this approach denies learners the opportunity to construct knowledge on their own. Having laid out the general points relating to the two teaching approaches, the researcher has outlined the discourses relating to science teaching methods inspired by these two broad teaching approaches. While both approaches have influenced the manner in which teachers design their teaching methods, it is evident that the learner-centred approach has had a far more pronounced influence on the way in which methods are designed and effected. Against this background, the perceptions that science teachers have about the methods they use in science teaching provides a general overview and the base of the study.
Drawing on relevant literature, the study demonstrates that while most teachers perceive learner-centred inspired methods to be more appropriate, the perception does not bear out in practice. To the contrary, they still prefer using methods that align with the teacher-centred approach. These perceptions form the framework against which the perceptions of Finnish and Namibian science teachers will be assessed.

Due to a number of similarities and differences in the educational systems of Finland and Namibia, it provided a good setting to conduct a case-based cross-national comparative study. Therefore, the main findings of the study are that Finnish Middle school sciences teachers tend to apply experimental teaching methods more as compared to Namibian Middle school science teachers. While Namibian Middle school, science teachers tend to apply small-group working methods more as compared to Finnish Middle school science teachers. Because the experimentation methods require laboratory equipment, the differences in approach in the Namibian context are due to limited resources. In addition, the study further reviews the teachers’ reasons behind the preferences of the teaching methods; their perception of science education; and their assessment of the implementation of the teaching methods. In light of this observation, this study concludes with the observation that both countries need to allow a variety of teaching methods regardless of whether they are emanating from either the learner-centred approach or the teacher-centred teaching approach. Nonetheless, appropriate teaching methods are effective in achieving the desired educational goals.

1.1 Science education and teaching science

Science education is the main component of school curricula in almost every country. Science education is credited with the innovation and improvements in economies (Millar, 2011). Hence, it is essential to maintaining and developing the technical infrastructures, national securities and economic prosperities for the future. If well developed and executed, science education can provide a stable flow of graduates into high-level jobs that require advanced scientific knowledge and expertise (Millar, 2011). That is why some countries tend to invest significantly in the training of science teachers. Such training aims to equip them with effective skills in teaching that will enable them to “prepare and produce graduates needed to support economic growth and prosperity” (OECD, 2012, p.183). The realisation of the importance of science education led to several international initiatives of the early 1960s, which aimed to
prioritise educational policies to improve the quality and effectiveness of science education (Kilpatrick, 2012).

Additionally, Millar (2011) argues, science education should provide learners with the kind of understanding of science that citizens in a modern democracy should have. Every education system must strive in developing and promoting learners’ scientific literacy for “active citizenship and engagement of science as a cornerstone of contemporary culture” (Millar, 2011, p. 175). Therefore, the notion that science education should be left to a select minority should not be the norm in any modern-day society. Science education has similar universal scientific goals as recommended by Alberts (2009) and Cobern et al. (2010) which learners should achieve to improve science education effectively. These are “learners should know, use, and interpret scientific explanations of the natural world” (Alberts, 2009, p. 437). They should be able to “generate and evaluate scientific evidence and explanations; understand the nature and the development of scientific knowledge, and, participate productively in scientific practices and discourse” (Cobern et al., 2010, p. 82). A notion to note in this discourse is that the level of scientific literacy, proficiency, and performance are much higher in Finland as compared to Namibia. Finland ranks among the best-performing countries in the Organisation for Economic Co-operation and Development (OECD) (Bybee, McCrae & Laurie, 2009; OECD, 2010; OECD, 2014 and OECD, 2016). Namibia science education, on the other hand, is still in the infancy stage. As a developing nation, it faces challenges ranging from a lack of competent science teachers to limited science resources in schools. Despite having similar goals, these differences affect teaching approaches and the implementation of teaching methods in each country accordingly.

Progression in scientific research findings is resulting in technological advancement. Consequently, this progression in science and technology affects every aspect of life across the world bringing in the need for some countries to invest significant resources in science education. Countries with advanced knowledge of science and technology tend to attain more capabilities and grow their economies as compared to those where science and technological development still lags (OECD, 2013). Hence, nations investing in science education because “economies are now changing from physical capital to knowledge-based capital” (OECD, 2013; GRN, 2004, p. 10). Therefore, science subjects become the centre of attention, as they are the driving force behind the knowledge-based economies as stipulated by the Organisation for Economic Cooperation and Development (OECD, 2013). As Papadouris, Hadjigeorgiou...
and Constantinou (2016) states, schooling today focuses on the achievement of the social goals of society. Therefore, putting more emphasis on learning what is involved in the curriculum (knowledge and values) is vital. Knowledge in here takes a broader meaning that includes conceptual knowledge, skills, and competencies. The conceptual knowledge, skills, and values are what every country needs to achieve competencies in science as a building block for knowledge-based economies. Thus, sharing specific experiences, practices, and ways of discussing can help us construct specific components of needed scientific knowledge. In this study science subjects includes Biology/Life-Science, Geography, and Physical Science (Chemistry and Physics).

1.2 Science education and teaching science in Finland and Namibia

Finland and Namibia share some standard features regarding the training of science teachers. Namibia prioritises the “training of science teachers by giving them preferential bursaries” (Shikongo, Amathilha, Miranda & Dendeinge, 2011, p.16; MoE, 2007, p. 17). Finland, on the other hand, invests substantially in education to improve their educational system (Andere, 2015; Ripley, 2014). Unlike Namibia, Finnish school curriculum does not prioritise some subjects over others. Instead, it retains a dynamic balance between humanities and science subjects (Lavonen, 2009). In the Namibian context, preferential investment and improvement of mathematics and science education are done with the aim to advance the general quality of primary education. According to GRN (2004, p. 10), “quality primary education determines the value of tertiary education which is essential for effective functioning and achievement of a knowledge-based economy”. In the same vein, quality science education determines the “entry point for developing a self-educable learning society to which Namibia aspires” (MoE, 2007, p.17). Moreover, it provides the necessary scientific skills and technologies for the next generation in school science education. Investment in science education could likewise make Namibia an internationally recognised education system that capacitates the population to meet current and future market demands for skills and innovation (National Planning Commission, 2012).

Because schools in Finland have comparable resources across the board, it is relatively more straightforward to compare teaching approaches and the choice of teaching methods across all the schools. There is a general lack of sufficient resources in schools in Namibia. According to the national institute for educational development report on the teachers’ needs, “many
teachers found the lack of materials and resources in schools as an obstacle” in using and implementing some teaching methods (MoE, 2009, p. 39). It is strongly argued that many schools, especially in rural areas lack sufficient classrooms, essential physical facilities such as libraries, laboratories, and technical facilities (MoE, 2011, p. 10). Additionally, the lack of resources explicitly teaching materials affects the teaching and learning process negatively. Well-resourced schools, especially in urban areas, tend to perform better on average compared to some rural schools where learners and teachers struggle in using the scarce teaching materials (MoE, 2011).

1.2.1 Science education and science subjects in Finnish middle schools

Science education in Finnish context comprises of four main subjects namely Biology, Chemistry, Geography, Physics and Health education (Martin, Mullis, Foy & Hooper, 2016). Biology focuses on nature and ecosystems; life and evolution and, the Common Environment, which concentrates on the ecologically sustainable development. Geography focuses on the earth as a human’s home planet; the essential features of Europe’s geography; Finland in the world which includes Finland’s geography and landscape; interaction of nature and human activity in different regions of the country. Lastly, the Common Environment focussing on the environmental and developmental questions, locally and globally. Physics concentrates on the motion and force, vibrations and wave motion electricity and magnetism and, natural structures. Chemistry focuses on the air and water, raw material and products and, living nature and society. Lastly, Health educations focus on growth and development, healthy choices and health, society, and culture.

With the Finnish education science policy emphasising on quality, efficiency, equality and science education of international nature (Ministry of Education, 2006), Finland’s science education seems to be quite good. The science teachers are subject specialists and studied pedagogical studies (Ministry of Education and Culture, 2017). According to the Programme for International Student Assessment (PISA) reports, Finland has continuously ranked as one of OECD’s top performers in scientific literacy since the year 2000. It ranked the best in science literacy in PISA 2006 report (Bybee et al., 2009) ranked second best in science proficiency in PISA 2009 (OECD, 2010). It came to the fifth position in science performance among 2012 PISA participating countries (OECD, 2014) and ranks the fourth best in science literature according to PISA 2015 report (OECD, 2016). Certain aspects of the Finnish education system
have been credited for its success in science education. Firstly, the background of learners has little impact on their educational performance (OECD, 2010). Instead, according to PISA reports, Finnish learners are “creative and can work autonomously in applying their acquired scientific knowledge and skills to a wide variety of situations, which includes the unacquainted ones” (OECD, 2010, p. 74).

Secondly, according to Juuti, Lavonen, Uitto, Byman and Meisalo (2010), the core curriculum for Finnish basic education (Finnish National Board of Education 2004) does not require teachers to employ any specific teaching methods. Lavonen (2009) likewise ascertains that teachers have the independence in selecting the most appropriate pedagogical methods. They have been responsible for choosing teaching methods since the beginning of the 1990s when the national level inspection of learning materials was terminated (Lavonen 2009). Thus, the core curriculum only recommends that the approach supposed to be “phenomenon-based learning approach” (Symeonidis & Schwarz, 2016, p. 33).

Thirdly, Finnish educators tend to rely more on phenomenon-based teaching. Silander (2015a, p. 19) states that “phenomenon-based teaching is an educational concept derived from constructivism theories”. It is an approach that sees learners as active knowledge builders. Knowledge is built because of problem-solving from little pieces of information. Moreover, it is constructed out of the combination of new information with their prior knowledge. Information is not seen only as an internal element of an individual, but as being formed in a social context. One of the prominent benefits of phenomenon-based leaning is that it supports the socio-constructivist and socio-cultural learning theories, which see learners, work collaboratively in teams (Silander, 2015). The phenomenon-based approach includes elements of social-cultural learning, progressive inquiry learning, and problem-based learning (Silander, 2015).

Furthermore, the national core curriculum for Basic Education of (2014) demands that all schools must design and provide at least one study-period per school year for all the learners. Learners will then focus on studying a phenomenon or topics that are of particular interest to them (National Board Education, 2016). The teachers’ task is to instruct and guide the pupils in becoming lifelong learners by taking the individual learning approaches of each learner into consideration (Symeonidis & Schwarz, 2016). Therefore, it compels learners to participate in the planning process of these studies. Specific viewpoints, concepts, and methods are to be
drawn from the school subjects for the planning and implementation of these periods. Subsequently, creating a collaborative classroom practice, where learners work with several teachers simultaneously. Despite these observations, few commentators have observed that Finnish Middle school science teachers still favour teacher centred teaching approach (Juuti et al., 2010; Lavonen, 2009). Juuti et al., (2010) argue that Finnish science teachers are pedagogically conservative and teaching and learning take place mainly in a traditional way. Lecturing is the most applied teaching method. This notwithstanding, experimental teaching appears to be predominant. Apart from this, some notable challenges science education faces in Finland includes the lower interest of learners in science education (OECD, 2007). Therefore, it is this success story among other factors that have been a motivation to conduct a case-based cross-national comparative study of the teaching methods of science teachers between Finland and Namibia.

1.2.2 Science education and science teaching subjects in Namibian middle schools

Science education in Namibian context comprises of three main subjects namely Agricultural science, Life science, and Physical science. Physical science comprises of Chemistry and Physics, and Life science comprises of Biology and Health education. The main aims of Agricultural science are general agriculture, plants studies, animal studies, and farming technology. Table 1 below gives the summary of the content of Agricultural science for junior secondary.

Table 1: Summary of learning content for Grade 8 - 9 Agricultural Science

<table>
<thead>
<tr>
<th>Grade 8</th>
<th>Grade 9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topic 1 General Agriculture</td>
</tr>
<tr>
<td>1.1 History of Agriculture</td>
<td>1.1 Importance of Agriculture to the local community</td>
</tr>
<tr>
<td>1.2 The farm as a production unit</td>
<td>1.2 Environmental factors and plant growth</td>
</tr>
<tr>
<td>1.3 Farming systems in Namibia</td>
<td>1.3 Gender roles in agriculture</td>
</tr>
<tr>
<td>1.4 Conservation farming for sustainable agricultural production</td>
<td>1.4 Impact of HIV and AIDS on food security</td>
</tr>
<tr>
<td>1.5 Impact of HIV and AIDS on farm workers</td>
<td>1.5 Population density and agriculture</td>
</tr>
<tr>
<td>1.6 The condition of service for farm workers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Topic 2 Plant Studies</td>
</tr>
<tr>
<td>2.1 General aspects</td>
<td>2.1 General aspects</td>
</tr>
<tr>
<td>2.2 Fruit production</td>
<td>2.2 Cash crops</td>
</tr>
<tr>
<td></td>
<td>Topic 3 Animal Studies</td>
</tr>
<tr>
<td>3.1 General aspects</td>
<td>3.1 General aspects</td>
</tr>
<tr>
<td>3.2 Pig farming</td>
<td>3.2 Fish farming (aquaculture)</td>
</tr>
<tr>
<td></td>
<td>3.3 Dairy farming</td>
</tr>
<tr>
<td></td>
<td>Topic 4 Farm Technology</td>
</tr>
<tr>
<td>4.1 Use of farm tools and implements</td>
<td>4.1 Farm buildings</td>
</tr>
</tbody>
</table>

Adapted from Ministry of Education, (2015)
Geography focuses on developing desirable attitudes and behavioural patterns in interacting with the environment in a manner that is proactive, preserving, and nurturing. Acquiring knowledge, attitude, practices and awareness of epidemics such as HIV and AIDS. Using appropriate methods for observing, collecting, classifying, presenting, analysing and interpreting data. The use and application of geographical knowledge and understanding to maps and in verbal numerical, diagrammatic, pictorial, photographic and graphical form. Lastly the use of geographical methods to locate physical, natural and human features on a map or globe. Even though Geography forms part of this study, it must be noted that in the Namibian context, it does not form part of science education. Table 2 below summarises the content of geography for junior secondary.

Table 2: Summary of the learning content for Grade 8 and 9 Geography

<table>
<thead>
<tr>
<th>Themes/topics</th>
<th>Grade 8</th>
<th>Themes/topics</th>
<th>Grade 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Climatology</td>
<td>The atmosphere, weather instruments and data (graphs). Synoptic maps, Form of condensation, Precipitation and Climate of Namibia</td>
<td>1. Map work</td>
<td>Interpretation of human and physical features on a map. Scale and distance. Directions (16 divisions). Location (degree, minutes and seconds). Photographs, Contours, Cross-section and Interpolation of isolines</td>
</tr>
<tr>
<td>5. Economic</td>
<td>Development, Production Trade, Income and Aid</td>
<td>5. Economic</td>
<td>Agriculture, Fishing, Mining, Transport and Tourism</td>
</tr>
<tr>
<td>Geography</td>
<td></td>
<td>Geography</td>
<td></td>
</tr>
<tr>
<td>Geography</td>
<td></td>
<td>Geography</td>
<td></td>
</tr>
<tr>
<td>7. Regional</td>
<td></td>
<td>Regional Geography</td>
<td>Namibia: Physical features: physiographic regions, drainage, vegetation and climate. Regional position: SACU and SADC</td>
</tr>
</tbody>
</table>

Adapted from Ministry of Education (2015)

Life science focusses on the scientific processes that include measurements, Human Biology Health education, the characteristics of living organisms, plants as living organism and ecosystems. Table 3 below summarises the content of Life science for junior secondary.
Table 3: Summary of learning content for Grades 8 – 9 Life Science

<table>
<thead>
<tr>
<th>Grade 8</th>
<th>Grade 9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scientific Processes and Experimental Techniques</strong></td>
<td></td>
</tr>
<tr>
<td>Topic 1 Scientific processes</td>
<td>Topic 1 Scientific processes</td>
</tr>
<tr>
<td><strong>Health Education</strong></td>
<td></td>
</tr>
<tr>
<td>Topic 2 Sexual health and diseases</td>
<td>Topic 2 Sexual health and diseases</td>
</tr>
<tr>
<td><strong>Living organisms</strong></td>
<td></td>
</tr>
<tr>
<td>Topic 3 Living organisms</td>
<td>Topic 3 Living organisms</td>
</tr>
<tr>
<td>Topic 4 Passage of substances</td>
<td>Topic 4 Passage of substances</td>
</tr>
<tr>
<td>Topic 4 Cell theory</td>
<td>Topic 4 Cell theory</td>
</tr>
<tr>
<td><strong>Human Biology</strong></td>
<td></td>
</tr>
<tr>
<td>Topic 5 Human Biology</td>
<td>Topic 5 Human Biology</td>
</tr>
<tr>
<td>Topic 6 Nutrition</td>
<td>Topic 6 Nutrition</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td></td>
</tr>
<tr>
<td>Topic 7 Ecosystem</td>
<td>Topic 7 Ecosystem</td>
</tr>
</tbody>
</table>

Adapted from Ministry of Education, (2015)

Physical science, which includes Physics and chemistry, concentrates on the scientific processes, matter and materials, environmental chemistry, mechanics, and, electricity and magnetism. Table 4 below summarises the content of Physical science for junior secondary.

Table 4: Summary of learning content for Grade 8 - 9 Physical Science

<table>
<thead>
<tr>
<th>Grade 8</th>
<th>Grade 9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scientific Processes and Experimental Techniques</strong></td>
<td></td>
</tr>
<tr>
<td>Topic 1 Scientific processes</td>
<td>Topic 1 Scientific processes</td>
</tr>
<tr>
<td><strong>Matter and Materials</strong></td>
<td></td>
</tr>
<tr>
<td>Topic 2 Matter</td>
<td>Topic 2 Matter</td>
</tr>
<tr>
<td><strong>Environmental Chemistry</strong></td>
<td></td>
</tr>
<tr>
<td>Topic 3 The Gases of the air</td>
<td>Topic 3 Acids, alkalis (bases), metals and non-metals</td>
</tr>
<tr>
<td><strong>Mechanics</strong></td>
<td></td>
</tr>
<tr>
<td>Topic 4 Forces</td>
<td>Topic 4 Mechanics</td>
</tr>
<tr>
<td><strong>Electricity and Magnetism</strong></td>
<td></td>
</tr>
<tr>
<td>Topic 5 Electricity</td>
<td>Topic 5 Electricity</td>
</tr>
</tbody>
</table>

Adapted from Ministry of Education, (2015)

The Namibian government has prioritised science education. Basic education places much emphasis on science and mathematics education. These subjects are “deemed necessary for transforming the country into a knowledge-based and highly competitive society” (GRN, 2004, p. 10). It is believed that human capacities in science and technology can play an integral role in solving the country’s developmental problems. Therefore, “having a good quality of general basic education can equally improve the value of tertiary education” (MoE, 2007, p. 18) which is an essential foundation for the human resources required to build a sustainable and
competitive economy. Despite the importance of science education for the country as a whole, science education in Namibia still faces challenges for both teachers and learners. The main challenges include “poorly resourced schools; limited hands-on materials for teaching natural sciences; and clouded classrooms” (UNICEF, 2011, p. 25). The national curriculum similarly “seems not to be relevant to the daily lives of learners” (Ottevanger, Akker & Feiter, 2007, p. 12) as statistics indicate that “some qualified teachers still lack sound subject-content knowledge” (Nakashole, Auala, Amakutuwa, Ailonga & Shigwedha 2017, p. 45). The inadequacy of teaching educational programs (Ottevanger et al., 2007) mainly causes lack of sound subject-content knowledge. Extracts from teachers in the report of professional and resource development research confirm the above argument. “I do not know how that document the Broad Curriculum is, so it is a problem; I cannot tell more about the Broad Curriculum; I have not been introduced to the Broad Curriculum, just, to be honest, even at the college, I was not” (sic) (MoE, 2009, p. 39). The other reason why teachers lack sound subject-content knowledge is that teacher education is seen as the least attractive profession in Namibia. Ultimately, those who train to become teachers tend to be graduates who did not perform very well to qualify for courses that are deemed more prestigious. Once they get into teacher training institutions, the pedagogical training is as well not adequately dealt with appropriately (Ottevanger et al., 2007).

The Namibian basic education curriculum does not dictate the teaching methods teachers are supposed to be using. It only states that the approach to teaching and learning should be learner-centred teaching approach. It argues, “The preparation for a knowledge-based society requires a learner-centred approach to teaching and learning” (MoE, 2010, p. 4). Thus, teachers are at liberty to choose or develop the teaching methods they deem to be appropriate to attain desired learning outcomes. The achievement thereof brings in the different teaching methods; making every teacher come up or have a consideration of some teaching methods. It is interesting that even though the curriculum policy emphasises the use of learner-centred teaching approach, it is rarely applied in classroom practices. “Teachers still primarily dominate the actual classroom practices, while learners quietly copy notes from the blackboard” (Awe & Kasanda, 2016; MoE, 2009, p. 11). Notwithstanding the weaknesses highlighted so far, the author observed that Namibian science education is on a steady rise as many learners from high schools proceed forth to pursue different science-related careers at the Universities. The preferential bursary scheme (Shikongo, Amathilha, Miranda, & Dendeinge, 2011; MoE, 2007) that has been ongoing is producing competent science teachers.
2. Teaching Approaches and teaching methods in science education

This chapter outlines the discourses relating to the main approaches applicable to teaching generally, and to teaching science specifically. Teaching approaches are the theoretical ideologies, opinions, and norms that reinforce the way one goes about teaching. These views may be explicit and supported by research. They can still be intuitive views, which a teacher is not even explicitly aware. These Teaching approaches can be categorised into two main types, namely, learner-centred teaching approach and teacher-centred teaching approach. Generally, any teaching method can be informed by the tenets of the two broad teaching approaches. As shall be demonstrated, disagreements exist on which of the two approaches to teaching is more effective. Most commentators favour the learner-centred approach. This method is preferred mainly due to the perception that it allows learners to construct new knowledge. On this view, the knowledge thus constructed is more meaningful to them because it allows them to learn by doing. The teacher-centred approach is less preferred because it presumes that teachers are the ones that possess all the knowledge that learners need. According to critics, this approach denies learners the opportunity to construct knowledge on their own. The chapter further presents a summary of discourses relating to teaching methods. The methods discussed here include experimental teaching, small-group working, outdoor learning, resource-based learning, and creative problem-solving methods. As background to this discussion, it first highlights the strengths, weaknesses, differences, and similarities between the two broad teaching approaches.

2.1 Teacher-centred teaching approaches in science education

The teacher-centred teaching approach is a teaching philosophy in which teachers provide clear instructional guidance, explicitly clarifying the concepts and skills that learners are required to learn (Gurses, Demiray, & Doğar, 2015). Equally referred to as (traditional way of teaching) is an approach related to early stages of learning which sees learners solves well-defined problems through a series of stages with assistance from the teachers (Bruner, 1960 and 1971; Piaget, 1926; Vygotsky, 1962 and Wood, 1986). The provision of guidance is this concept can be through a variety of methods, such as lectures, modelling, videos, computer-based presentations, and practical demonstrations (Clark, Kirschner & Sweller, 2012; Kirschner, Sweller & Clark, 2006). The teacher further develops the strategies that support and are harmonious with the learners’ reasoning. Thus, learning, on the other hand, is the change in
long-term memory (Sweller, 2009). It gives much autonomy to teachers to dictate how teaching and learning supposed to take place and the possible outcomes. In a teacher-centred teaching approach, the teacher mainly uses teaching methods where learners sit back and listen to the dictates of the teachers (Silcock & Brundrett, 2002).

Interestingly, this seems to be a situation in Finland as Juuti et al. (2010, p. 619) contends that “learners seem to have accepted the traditional way to teaching and learning approach”. It is equally the most common teaching approach in Turkey (Gurses, Demiray & Doğar, 2015). “Lessons are taught by traditional methods at most Turkish schools” (Gurses et al., 2015, p. 48). The paradigm contrasts the constructivism theory, which views learning as when individuals actively construct knowledge with hands-on (Gunning, 2010). It argues that learning takes place when learners combine newly acquired knowledge with their prior knowledge (Tracey & Morrow, 2012). Thus, for this to take place, learners must be practically involved as they are the ‘constructors’ of the intended knowledge. However, decades of research demonstrate that “a teacher-centred teaching approach is more effective and efficient than a learner-centred teaching approach for almost all learners” (Clark et al., 2012, p. 6). They further argue that only for experts does learner-centred teaching approach significantly effective and efficient.

The primary goal of the teacher-centred approach is explicitly to assist learners to develop strong readily accessible background knowledge. This is achievable by enabling learners to rehearse and connect the background knowledge to other facts. As the most successful teachers ensure that, “their learners efficiently acquire, rehearse, and connect background knowledge by providing them with a good deal of instructional support” (Rosenshine, 2012, p. 12). In a teacher-centred teaching approach, teachers initiate learning. They direct the learners into discussions, encouraging those that are in line with what the teacher intends to achieve and correcting those that seem to deviate from the intended path. The role of the teacher is visible, explicit and tied to identified content or skills. The teacher has the overall direction and responsibility of the learners’ academic achievement. They prepare presentations and demonstrations; make learners drill and practice as they pose numerous factual questions. Moreover, “they similarly give immediate feedback and correction as a way of enabling learners to master the curriculum contents” (Clark et al., 2012, p. 7). Westwood (2008) argues that it does not fundamentally necessitate ‘hands-on’ to switch ‘minds on’ but the clear and direct explanation and presentation stimulates thinking (p. 5). High-quality learning
instruction, which includes modelling and direct explanation, involves learners in a better situation of mental activity (Kirschner et al., 2006).

According to critics, this traditional way of teaching can influence learners negatively as it lacks innovation. It might lead to amotivation instead of the motivation of learners towards science, as they will always know which role to take in every pedagogic situation. Thus, motivation among learners may diminish, and they may become less enthusiastic in the science subjects. This might explain why the National Research Council, (2011) revealed that about 75% of eighth graders in the United States (US) are not adequately proficient in science by the time they complete the grade. It further revealed that only 10% of the US eighth graders meet the trends in international mathematics and science study (TIMSS). Thus, a postulation can be made that the traditional ways of teaching (teacher-centred) such as lecture methods and makes it difficult for learners to study sciences because they do not have a voice in the selection and organisation of learning activities (Awe & Kasanda, 2016). As a result, a constant decline in the number of students majoring in sciences in universities has been on the rise (Osborne & Dillon, 2010).

Besides this argument, it should be noted that the poor performance in science education by US eighth graders could be attributed to (Learner-centred teaching) the constructivism teaching approaches (Sweller, 2009). This approach fails to recognise that secondary knowledge, which is acquired mainly through educational institutions, need explicit teaching as opposed to primary knowledge, which humans have evolved to acquire. Human beings have not evolved to read and write in the same way as they have evolved to listen and speak. Listening and speaking being primary knowledge, and reading-and-writing being secondary knowledge (Sweller, 2009). Thus, learner-centred teaching approach, which advocates for “the withholding of easily presentable information from learners so that they can discover knowledge rather than explicitly providing them with essential information, can result in minimal learning” (Sweller, 2009, p. 127). Learner-centred teaching approach of constructivism that includes scaffolding requires learners to engage in inquiry without explicit instruction. “Inquiry is a term equated to research or investigation; it means seeking explanations or information by asking questions” (Harlen, 2013, p. 13). For reasons not well explained, it assumes that learning takes place when learners solve tasks with little explicit instruction concerning the possible outcomes (Sweller, 2009). It is from these shortcomings of learner-centred approach that a significant number of teachers seem to opt for a teacher-
centred approach for they take charge of learning by providing explicit instructions to learners (Gurses et al., 2015; Juuti et al., 2010).

### 2.2 Learner-centred teaching approach in science education

Learner-centred teaching approach is a teaching philosophy in which “learners construct new knowledge through discovery as opposed to being presented with indispensable information” (Westwood, 2008, p. 27; Kirschner et al., 2006, p. 75). Different theorists have referred to learner-centred teaching approach by various names which includes “minimally guided approach, discovery learning, problem-based learning, inquiry-based learning, experiential learning, and constructivist learning” (Clark et al., 2012, p. 7; Sweller, 2009, p. 63; Westwood, 2008, p. 27; Kirschner et al., 2006, p. 75). The original philosophies of constructivism where learner-centred teaching approach originates go back from the learning theories of John Dewey, (1933), Jean Piaget, (1983) and Jerome Bruner, (1961). These philosophers argued much on the need for hands-on experience in shaping human learning and understanding. They further stressed the need for and recognition of prior knowledge as an essential aspect of learning and acquiring new information. In this approach, it is essential for teachers to understand the unique perspective of every learner in order to be in touch with and better understand each learner and their needs. Silcock and Brundrett (2002) argue that in a learner-centred approach, teachers neither can nor should deliver a set curriculum but rather teach learners how to access curricula themselves. The primary learning emphases are the outputs needed, not the specified content. Therefore, learners’ commitment is required in the acquisition of the necessary skills and attitudes to bring about the needed results.

Unlike in teacher-centred approach, in learner-centred approach teachers becomes facilitators of learning and learners themselves construct new knowledge building it from their prior knowledge (Tracey & Morrow, 2012). In this manner, the teacher helps learners to develop individual thinking and problem-solving abilities (Schreno, 2016). The teacher likewise becomes a mediator of learning through interviewing and assessing the learners’ thinking processes. As a result, the teacher enables learners to deduce new meanings about essential problems, concepts, and issues. Thus, helping learners to be able to plan and evaluate the thinking processes they can use in gathering information, attempting to solve problems and to make decisions.
The primary goal of a learner-centred approach is to encourage children to develop greater decision-making and problem-solving skills, hence promoting greater independence. Therefore, this approach involves and engages learners’ minds in creative activities. Additionally, Schrenko (2016) contends that the learner-centred approach promotes learners’ intrinsic motivation and instructional practices such as asking higher order questions, modelling, and mediating thoughts. Hands-on problem solving is very effective in assisting learners to learn abstract concepts and positive feedback. It is effective in encouraging and allowing learners’ multiple opportunities to practise and improve their learning. In this way, learners are motivated to be creative in their learning as they are of different abilities. The teacher enables learning by creating favourable conditions, which caters to these varying abilities. Furthermore, Schrenko (2016) argues that the use of a learner-centred approach helps learners to be more independent, resourceful, interactive and cooperative. It helps them at the same time to build interpersonal relationships. In the twenty-first century, the business world demands workers to function as a team. Many learners will want to enter careers in business when they finish their schooling. Thus, learner-centred teaching approach prepares them for cooperative skills at an early stage before the inception of their careers as they interact and work cooperatively (Gillies, 2014). Learner-centred teaching approach creates learning environments (in the classroom or online) which encourage learners to examine their current beliefs. It empowers them to explore new ways of thinking and experience that require them to re-formulate their understanding (Aldajah, 2014).

Many educational systems are adopting learner-centred teaching approach with the perception that it enhances the learners’ attitude and performance in their subjects (Ottander & Ekborg, 2012), and it is based on the constructivism theory. Constructivism theory argues that learning occurs when individuals integrate new knowledge with existing knowledge (Tracey & Morrow, 2012). Rather than being presented with needed information about the content as in teacher-centred approach, learners discover and construct the essential information for themselves (Bruner, 1961; Papert, 1980; Steffe & Gale, 1995). This integration can only occur when learners are actively engaged in the learning process (Tracey & Morrow, 2012). Thus, learner-centred teaching approach is an active teaching and learning process. Many recommended learner-centred teaching approaches have been implemented in science subjects as authors argue that these methods enhance learners’ attitude to, and performance in, science subjects (Klosterman & Sadler, 2010; Ottander & Ekborg, 2012; Kang & Keinonen, 2018).
Many education systems today seem to be inclining more towards the constructivism teaching approach (learner-centred teaching approach) as opposed to the instructivism teaching approach (teacher-centred teaching approach). Even the revised curricula rolled out in Finland and Namibia are both based on constructivist teaching and learning philosophies. In Finland, constructivism teaching is dubbed phenomenon-based education system (Silander, (2015; NBE, 2016) while in Namibia the approach is termed a learner-centred education system (MoE, 2010). Despite its popularity, there is research that raises questions about the superiority of the learner-centred approach. According to Clark et al. (2012), researchers investigated whether learners of science subjects learned more via learner-centred approaches compared to teacher-centred approaches. They equally investigated whether the quality of learning differed once learning had occurred in either of the mentioned approaches. They further individually tested whether those who had learned through learner-centred approach were able to transfer their learning to new contexts as compared to those of teacher-centred approaches. The findings were that teacher-centred approaches, which involved much guidance, including examples, “resulted in vastly more learning than learner-centred approaches” (Clark et al., 2012, p. 7).

Contrary to constructivist views of learning, Sweller (2009) and Kirschner et al. (2006) argue that constructivism approach to teaching and learning is significantly less effective and efficient than a teacher-centred approach. Sweller (2009) further argues that constructivists’ learner-centred has failed to produce convincing empirical research based on randomised controlled experiments to demonstrate its effectiveness as a teaching approach. They further contend that the design of teacher-centred teaching approach supports the cognitive processing of learning. Additionally, the constructivists’ learner-centred teaching has less effect in learning especially for the novice and intermediate learners (Sweller, 2009). The strong guidance in a teacher-centred approach is most often more effective as compared to the learner-centred approach even for the learners with considerable prior knowledge (Clark et al., 2012). The less effectiveness of learner-centred approach may result in making learners to acquire misconceptions and incomplete or disorganised knowledge (Sweller, 2009). The characteristics of withholding information from learners with a notion that they will discover knowledge can be responsible for such a poor acquisition of knowledge. That is why learners need to be provided explicitly with the necessary information needed for them to construct knowledge. The primary purpose of instruction is to alter long-term memory; therefore, “if nothing changes in the long-term memory, then nothing has been learned” (Kirschner et al., 2006, p. 77). Hence, if an approach does not specify the procedures to be followed by learners, the needed change
in long-term memory due to instruction might not take place thus learning might not have taken place equally (Sweller, 2009). Based on these arguments, this research identifies the preferred teaching methods in selected schools regardless of whether the methods are learner-centred or teacher-centred.

The debates presented show that there is not a conclusive basis to conclude that one teaching approach is better than the other in all contexts. In this regard, Westwood, (2008) argues that that debating on which approach is better than the other is a misguided exercise; just as (Sweller, 2009) argues that none of the approaches is better than the other. The significant thing is for teachers to choose the best approach when teaching specific curriculum contents. Some topics can be taught well through a teacher-centred approach while the other topics can be taught well through a learner-centred approach (Sweller, 2009). Thus, each teaching approach is relevant in the overall context of pedagogy even though they might differ in the effectiveness of achieving specific learning competencies. Westwood (2008) further argues that understanding the rationale behind learner-centred and teacher-centred approaches is essential for teachers. It helps in guiding them in the selection of effective teaching methods according to different types of subject matter. Learner-centred teaching approach focuses on the more profound conceptual realisation to bring the desired change in learners. Teacher-centred teaching approach, on the other hand, considers the effectiveness of the transmission of information and skills from the teacher to the learners (ibid). Clark et al. (2012) refer to the same teaching approaches as “minimally guided instruction (learner-centred) and fully guided teaching respectively” (p. 7).

**2.3 Teaching methods in science education**

Teaching methods refer to the series of interrelated and progressive steps executed by teachers and learners to attain the set learning competencies as stipulated in the curricula or syllabuses (Westwood, 2008). Science teaching requires teachers to pay attention to the specific content being taught, and how best to teach it. This is to be followed by allowing learners to have a mental migration from their initial state of knowledge and understanding to the desired outcome (Daehler, 2016). That is why the demand for quality teaching and learning is one of the most challenging concerns in the teaching profession (Ornek & Saleh, 2012). As a result, the overriding question is no longer, why science should be taught, but rather how should it be taught. Therefore, teaching science should enhance learners’ conceptual understanding of
scientific concepts to enable them to apply the knowledge to solve real-life problems. In a bid to find effective science teaching methods, curriculum developers have proposed lists of teaching methods from which teachers can choose. Their intention is usually to help those who might be inadequately acquainted with the latest teaching methods. The purpose of these contemporary methods of learning is to create a science teaching profession that is equipped for the tasks of this century (Schleicher, 2012). Whether inspired by the teacher-centred approach or by the learner-centred approach, all teaching methods can play a role in enhancing learners’ learning experience. On this point, Silcock and Brundrett (2002) have argued that various teaching methods used by teachers are all relevant. According to these authors, it is not advisable to dismiss some of these methods just because they are out of tune with the latest thinking. Table 5 below shows some examples of the science teaching techniques that can fall into five commonly applied methods (Juuti et al., 2010; Lavonen, n.d.)

### Table 5: The categories of teaching methods in science education

<table>
<thead>
<tr>
<th>Methods</th>
<th>Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental teaching methods</td>
<td>Lab work/Class Practicals, Discovery, Teacher demonstrations, Small group practicals</td>
</tr>
<tr>
<td>Small-group working</td>
<td>Group works, the pair works, Role-plays, Debate</td>
</tr>
<tr>
<td>Resource-based learning</td>
<td>Individual work, Reading/writing, Mind mapping, Class discussion</td>
</tr>
<tr>
<td>Creative-problem solving</td>
<td>Concept maps, Problem-solving, Brainstorming</td>
</tr>
<tr>
<td>Out of school, informal learning</td>
<td>Fieldwork</td>
</tr>
<tr>
<td>Teacher-led, large-groups lecturing</td>
<td>Lecturing, Storytelling, Educational videos, Question &amp; Answer</td>
</tr>
</tbody>
</table>

It may be true that innovative techniques arising from new grounds for learning and intellectual development work well because they extend or develop teachers’ current thinking rather than contradicting it. However, a thorough look at the way teachers teach has the potential of grasping the nature of good teaching. As Papadouris et al. (2016) stated, people could shape, organise, and give specific meaning to knowledge depending to which group they belong. It can be argued that the needs of this century have created a demand for a particular type of knowledge or types of knowledge. This knowledge needs to be reshaped and organised by the people so that it can provide specific meaning relevant to the needs of this century. More specifically, the techniques should be relevant to teaching science subjects in schools (junior
secondary in particular). As (Mykrä, 2015) observes, there is a need to position learning in the context of meaningful activities in order to make it more applicable in real life situations. In the present systemised formal education system, the majority of schools have curricula and syllabuses that outline the possible intended learning outcomes of every science teacher’s teaching. However, these national documents do not dictate as to which specific teaching methods teachers are supposed to use. A more detailed discussion of these methods and techniques follow. In each method, a detailed argument of a selected technique is provided as an example of its applicability in teaching science education.

2.3.1 Experimental teaching methods in science education

Experimental teaching methods is a category characterised mainly by conducting hands-on practical activities to investigate and analyse a phenomenon. These pedagogical activities have been used in science education since the middle of 19th century (Duru, 2010). Experimental teaching methods allow learners to search for explanations and/or specific information by asking relevant questions that lead them to an inquiry.

In experimental teaching methods, teachers provide an environment that allows learners to explore possible scientific explanation. It is an investigative method of teaching. Learners have the opportunities to investigate scientific problems using tools to observe, gather, analyse, and interpret data as they search for workable solutions. They learn to ask questions using theories and models to explain phenomena and ideas evaluated against alternative explanations and compare with evidence. Knowing why the wrong answer is wrong helps secure a more profound and stronger understanding of why the right answer is right. It further tests out ideas and enables learners to think creatively and use their intuition (Harlen, 2013). Experimental teaching methods allow learners to be engaged in investigating scientifically orientated questions where they learn to give priority to evidence, evaluate explanations considering alternative explanations, and learn to communicate and justify their decisions. It further requires coordination of both knowledge and skills simultaneously in the learning process leading to learners being able to investigate and build their knowledge and understanding of the world around them (National Research Council, 2012).

There are two prominent forms of experimental teaching methods, namely, guided inquiry and open inquiry (Kang & Keinonen, 2018). The difference between the two inquiries is that the guided inquiry has much supervision by the teacher as he/she formulates the topics for
investigation. The open inquiry has minimal supervision as it starts with the learners developing questions for investigation (p. 868). Under this technique, the methods of study can be either lab-work/class practical, teacher demonstrations, or small-group practical. Inquiry-based learning presents a new teaching practice, which replicates real-life situations for learners. It emphasises the provision of opportunities to the learners for them to apply their knowledge and skills during activities. In so doing, enriches their knowledge and improves their skills (Habók, 2016).

Recently, there has been an active promotional surge in the use of inquiry-based teaching methods in science education. These are experimental teaching methods characterised by the unguided or partially guided instructional approaches (Clark et al., 2012). Generally defined as teaching methods in which learners, rather than being presented with necessary information, must discover or construct needed information for themselves (Sweller, 2009). The reasons for this surge are that inquiry-based teaching has the potential to help learners have a deeper understanding of science education. It equally stimulates their interest and attitudes in science education with the advantage of the ever-increasing technological base in society (Harlen, 2013). Inquiry-based teaching allows learners to develop critical scientific concepts gradually through learning how to explore and build their knowledge and understanding of the physical world. Learners within a science setting acquire skills that would allow them to comprehend scientific facts through logical thinking and critical analysis. Hence, in science education, they learn by raising questions and proving or disproving known scientific theories. In essence, learners would have to consider normal science where they need to get into the laboratory, carry out tests, and get the findings. They can equally use the outside world to collect data through observation and investigation; then compare with known scientific research findings to conclude. In so doing, it enables learners to become active participants in knowledge creation as opposed to knowledge recipients. Notably, the pedagogical concept of inquiry-based teaching is not necessarily a new phenomenon in education. It traces its origins from the theories of educationists which includes Dewey (1870-1952), Homer Lane (1875-1925), Montessori (1870-1952), Rousseau (1712-1778), Pestalozzi (1746-1827), and Froebel (1782-852) who championed the constructivist teaching approaches (Harlen, 2013).

### 2.3.2 Small-group working in science education

Small group teaching is any teaching situation where learners in a class are put in groups of the sizeable number in which they can learn collaboratively in a manner that maximises dialogue
within the group (Mills & Alexander, 2013). Though there is no predetermined appropriate size for a group, a group composed of not more than eight members is considered more effective. (p. 4). Regardless of the size of each group, the teacher is still vital in ensuring active learning takes place. The teacher’s role is that of a facilitator or coordinator who sees that the group is inspired and communicates as they socially construct new knowledge (Campbell, 2015; Tracey & Morrow, 2012). Examples of small-group working include debate, group work and/or pair work, role-plays or drama. Studies

Generally, these techniques are grounded in the learner-centred approach. A comprehensive discussion of each of the techniques highlighted above is beyond the scope of this study. However, a short discussion on the drama technique is provided as an illustration of how the small-group working methods could be applied. Drama is a teaching method that allows learners to explore and demonstrate scientific concepts through role-plays. It is a participatory way of learning that creates interaction between learners and a simulated scenario (Kilgour, Reynaud, Northcote & Shields, 2015). Before science, teachers started using it in science education; drama was already in use in humanity-subjects of languages, pronunciation, religion, classics and history. Science teachers have used drama in demonstrating various scientific concepts. Braund (2015), lists three main areas where drama can contribute significantly in science education; these include science concepts, the nature of science and about science’s interactions with society (p. 105). It has been used to illustrate the particle theory of matter where learners act as atoms within different states of matter. Similarly, it has been used to demonstrate physical modelling of electric circuits (Dorion, 2009). These role-plays are intended to serve as improvisation rather than as scripted drama performances. Dorion (2009) contends that drama-type activities such as role-plays support intellectual development; emotional and procedural objectives; and higher order thinking skills, which are related to analysis, synthesis, and evaluation. Drama activities stimulate an interactive dialogue amongst the learners by inspiring them through role-plays (Kambouri & Michaelides, 2014). It assists learners’ understanding of more abstract scientific topics that positive outcomes were observed when used in teaching chemistry, biology and physics in the UK schools (Kambouri & Michaelides, 2014; Dorion, 2009).

It would appear that the constructivist theory informs drama. Based on constructivism theories, dramatising is an active learning activity were learners achieve deep learning that improves the retention and remembering of facts as they conceptualise the experiences. Most learners find drama to be motivating because it includes active involvement and opportunity to make
personal choices as they construct scientific concepts through role-playing. Thus, they learn by doing or with hands-on (Bixler, 2011; Kilgour et al., 2015; Westwood, 2008). Like drama, other techniques within this method are also shaped by the learner-oriented approach. However, some critics like (Lee, Patall, Cawthon, & Steingut, 2015) states that drama as a teaching method in science education has much effect on the learners’ motivation compared to their achievement outcomes. It helps younger learners’ achievement outcomes more preferably in primary school as compared to achievement outcomes of those in middle school.

2.3.3 Outdoor learning and fieldwork in science education

Outdoor learning refers to organised learning activities that take place outside of class setting in predominantly outdoor environments. It focusses on the educational value of learning in the outdoors. Referencing John Dewey, James and Williams, (2017) emphasise that outdoor learning is an essential ingredient in meaningful and comprehensive pedagogy. Known also as fieldwork, it includes lessons allows for investigative, discovery and experiential learning. Goulder (2012) argues that outdoor learning provides the first-hand experience of biodiversity and ecology to the learners especially those studying biology/life science and geography. It facilitates the acquirement of transferable scientific skills such as recording and interpretation of scientific data. By forcing learners to team up in groups and have regard to safety awareness, this method further promotes the ability of the learners to work in teams.

Outdoor learning motivates learners because it allows them to make scientific concepts much more meaningful to them. This point is illustrated by a study conducted by John and Williams, (2017) which sought to examine the effectiveness of outdoor learning in Geography. They report that middle school learners perceive outdoor learning to be an enjoyable and worthwhile experience because it allows them to collect real data as they learn about the environment (P. 64).

Lock (2010) contends that outdoor learning “impacts positively on the cognitive and affective well-being of learners. It equally improves their “social/interpersonal and, physical/behavioural well-being” (p. 58). Substantial evidence exists that outdoor learning allows learners to have opportunities for developing their skills and knowledge in ways that add value to their everyday experiences in the classroom. Another important aspect of outdoor learning can be found in Vygotsky’s social constructivism of scaffolding. This is the technique
where adults and peers that are more competent provide support to the less competent learners during learning episodes (Tracey & Morrow, 2012). This can be done by breaking down the problem into steps; giving clues, reminders, encouragement or anything else that allows the learners to grow in the independence of learning. Thus, scaffolding the learning from the classroom to the field and then back to the classroom results in significant, comprehensive, and long-term learning (James & Williams, 2017).

Outdoor learning is an essential component of developing research skills for the learners at a tender age as they engage in a variety of exploratory and memorable challenges. They apply the research skills taught in class when they engage in outdoor learning activities. In addition to building research skills, “it helps learners feel more involved in their discipline” (James & Williams, 2017, p. 66). This is because out-door lessons are mainly informal in nature thus allows learners to have a chance of engaging more informally with their teachers which creates a strong bond.

Outdoor learning is more beneficial to learners who struggle with traditional school tasks or have lost interest in learning and schooling (Barlow, 2015). Overall, both learner-centred and teacher-centred approaches can inform outdoor learning. The determining factor is the level of autonomy the teacher grants to the learners.

2.3.4 Resource-based learning in science education

Research in science refers to a learning situation where learners learn by active processing of information from various resources (Brown and Smith, 2012; Westwood 2008). These sources can include research books other than only science textbooks, class summaries, libraries, community publications, videos and websites or by talking with experts. Using this method, learners learn and develop useful skills on how to use the library catalogues, carry out electronic searches, make telephone calls to seek information, conduct interviews, send and receive emails, and, write and read (Westwood, 2008, p.35). Learners use all these resources to obtain the needed information related to a chosen or set topic that they then organise, analyse, evaluate, and consolidate into an appropriate order for presentation. As it is mainly an independent learning style, it demands learners to develop independence in searching for information. Because of its autonomous nature, it is a teaching method, which can be applied
across the curricula, and skills developed by the learners as they search for information from various sources can easily be transferable to others.

Many learners find the method motivating because it involves active participation, hands-on materials, and opportunities to make personal choices (Westwood, 2008). The individualistic approach that it gives learners makes them have a deeper understanding of subject matter and “encourages self-directed learning” (p. 35). It further facilitates and strengthens the independent use of research skills. Living in an information age, research enables learners to exercise, improve, and increase their confidence in information-communication technology competencies. As a result, the acquired study skills are easily transferable to other areas of their curriculum and peer teaching. It sees time on task increased as they independently study and review all the resources they have without supervision from their teachers. Furthermore, learners learn to appreciate the value of information resources such as libraries, internet and resource rooms which eventually improves their attitude toward reading.

One technique under the resource-based learning method is the so-called concept/mind mapping. Concept/mind mapping is the creation of graphical presentation of concepts, facts, terms and ideas within a learning task (Safar, 2014). They can be structured according to the questions to be answered, and these questions in a map are called focus or central idea. “A connecting line links concepts and stipulates the relationship between the two or more concepts” (Safar, 2014, p. 632). Integrating concept/mind maps into science education as a teaching method empowers learners to contemplate passionately about science. New science concepts when presented to the learners usually makes them undertake a cognitive procedure to make sense and create meaning about the new information. Therefore, creating concepts maps allows learners to reclassify and arrange what they learn (p. 643). Concept/mind mapping allows learners to visualise the relationships of essential science concepts and ideas in a systematic approach. It enables them to gather, save, and retrieve information more effectively and efficiently. Learners are empowered to articulate and contest their views about science when they share their concept/mind maps. (Safar, 2014).

2.3.5 Creative-problem solving teaching method in science education

Creativity-problem solving is the ability to produce different ideas of inventiveness in answering learning tasks (Vidal, 2010). Therefore, creativity is an essential aspect of teaching
and learning science as it forces learners to broaden their abilities. Creative-problem solving as a teaching method involves the ability of higher order thinking skills, such as summarising, analysing and making inferences and deductions (Carr Éireann, Cliath & Rúnaí, 2007). When science teachers incorporate tasks that have to do with observation, organising, evaluating and identifying essential evidence helps learners to make informed judgements about what they are being taught (p. 23). Consequently, learners will be able to discover new contents when doing tasks that require problem-solving. Additionally, creative problem solving enables learners to use their prior knowledge and experience to discover the truths and facts. It is essential for science teachers to ensure the application of creative problem-solving in the teaching. It facilitates learning, which, according to Vygotsky, allows a child to successfully acquire new knowledge with appropriate support (Temple, Ogle, Crawford & Freppon, 2011).

2.3.6 Teacher-led large-group lecturing in science education

Teacher-led, large-group lecturing in science education is used in conveying information to learners while allowing the teacher to have the total control of the teaching and learning experience (McMullan, 2016). It is the provision of necessary information that fully explains the scientific concepts and procedures needed by the learners in learning (Clark et al., 2012; Sweller, 2009; Kirschner et al., 2006). In science education, teacher-led large-group or lecturing teaching method (traditional way of teaching) underscores the necessity to plainly describe the procedures learners are to follow in a learning task. Clark et al. (2012) argue that if well implemented, lecturing and/or teacher-led large-group discussions can be superior to other teaching methods like discovery which makes learners wonder in trying to discover knowledge (p. 9). As research has it that explicit presentation of science, contents especially if the information is novel help learners to contextualise and develop dip understanding of what is being taught. The communication mainly is led and controlled by the teacher thus the discussion is of the entire classroom as the teacher and learners’ interchangeable pose and answers questions. It is the best teaching approach in introducing the whole new topic or concept to the learners especially those of primary and middle schools. This is supported by arguments from South African teachers who argue that “lecturing is more effective in explaining scientific concepts” (Ramnarain, 2014, p. 72).
3. Teachers as users of science teaching approaches and teaching methods

This chapter analyses the perceptions that science teachers generally hold about the effectiveness and desirability of the teaching approaches and methods outlined in chapter 2. It contains a detailed analysis of how and why it is essential to shape the pedagogical approach in science subjects and how to improve the teaching methods. In order to lay a good background of the analysis of the views of teachers, a few countries have been selected which includes Finland and Namibia in order to have a broader view of teachers in their respective countries. The selection is not necessarily purposeful but a random selection in order to enrich literature. This analysis provides a framework against which the findings of the case-based study are assessed.

Many countries have undergone reforms and initiatives to shape teaching and learning in science subjects. Scholars argue that for learners to be fully prepared for careers in science-related fields, they should be able to engage in pedagogical practices that reflect the interdisciplinary nature of the science subjects (Siew, Amir, & Chong, 2015). Thus, through collaboration, science teachers can be exposed to different teaching methods used by other teachers with the potential of bringing variety to the teaching methodology (Carr et al., 2007). In addition, teachers seem to apply different teaching methods accordingly at different times. Previous research by Juuti et al. (2010) reviews that teaching methods that enable teachers to be approachable by learners facilitate learners to develop an interest in the subject (p. 612). Teachers who can spend time listening to the queries raised by individual learners and recognising their efforts by praising their performances are more likely to achieve their teaching goals. Flexible teachers who have regard for learners to do the work in their way are the most desirable. Some teaching methods that have a reasonable level of interaction between teachers and learners helps learners to internalise the aims and goals of the curriculum, which in return is essential for individual interest development in the subject. These beneficial characteristics are more prevalent in learner-centred inspired approaches. Therefore, a variation of teaching methods can complement learning as learners have varied personalities and learn in different ways. Here, again, methods informed by the learner-centred approach are associated with better socio-emotional effects. This explains further, the favourable perception that teachers hold about the learner-centred approach when contrasted with the teacher-centred approach. They view these methods as the teaching methods that do facilitate not only the acquisition of knowledge but also helps the acquisition of knowledge by learners with low
language proficiency skills (Habók, 2016). It caters to the needs of differently abled learners helping them in finding achievable tasks, which might still pose a challenge to them.

A critical aspect of learner-centred teaching methods is that teachers are more of facilitators and learning guides. Habók (2016) argues that through using inquiry-based learning (which of course emanates from Learner centred approach), learners can easily acquire essential skills because they learn by doing. He noted that skills such as the development of communicative competence and the accomplishment of communicative goals could be nurtured through cooperation and learning by doing (p. 4). Additionally, it also improves their motivation and, the development of cognitive and metacognitive strategies. As Siew et al. (2015) noted teachers could guide learners in small groups to develop a variety of solutions for a given problem. This improves collaboration among learners and strengthens critical thinking and communication skills. Learners can actively design and make artefacts in solving the given problem. Moreover, it allows them to carry out a series of experiments that relate to science content with hands-on activities (Siew et al., 2015). Thus, choosing the suitable teaching methods can arouse and enhance learners’ interest. Juuti et al. (2010) further argue that this can give positive feelings that can boost their knowledge acquisition and development. Additionally, teaching methods that appeal to the interests of learners promote positive socio-emotional effects (p. 612). Similarly, teaching methods that emanate from inquiry-based learning have received many reviews from science teaching fraternity in recent years (Ramnarain, 2014). In Ramnarain’s (2014) study, a majority of teachers indicated a positive perception towards the use of inquiry-based teaching methods. They argue that inquiry-based teaching helps to develop learners’ experimental skills and makes science more enjoyable (p. 71).

3.1 Finnish science teachers as users of science teaching approaches and teaching methods

Despite the broad favourable perception of learner-centred inspired methods, not all hold this perception. An interesting finding by Juuti et al. (2010) and Lavonen (2009) reviews that Finnish science teachers seem to prefer using teaching methods that are teacher-centred driven the most. Being pedagogically conservative, Finnish science teachers seem to favour teaching methods that emanate from teacher-centred teaching approach which involve the whole group of learners. Hence, through lecture teaching method, they can support learners in creating
meaningful and understandable knowledge by “asking questions and supporting learners in explaining, reasoning, and organising practical work” (Clark et al., 2012, p. 7). It is therefore not surprising that teacher-centred or direct instruction seems to be the most popular teaching methods in Finland in physics and chemistry. Teachers present new material or solve problems on the blackboard. Demonstrations and practical work followed in the second class of popular teaching methods (Juuti et al., 2010, p. 926).

3.2 Namibian science teachers as users of science teaching approaches and teaching methods

In the Namibian context, the curriculum policy emphasises the use of teaching methods which emanate from learner-centred teaching approaches (Awe & Kasanda, 2016; MoE, 2009), but interestingly this seems not be what is on the ground. A ministry of education teachers’ report of professional and resource development research revealed that “Namibian science teachers still primarily dominate the actual classroom practices, while learners quietly copy notes from the blackboard” (MoE, 2009, p. 11). Majority of Namibian science teachers are aware of the term ‘learner-centred education’ but think that it means group work (Awe & Kasanda, 2016). Teachers use various teaching methods to support knowledge acquisition of the learners without knowing whether the methods are teacher-centred or learner-centred. Remarkably only a few of those methods used emanates from a learner-centred approach. Majority of the teaching methods do not promote co-operative sharing of knowledge, which is a typical characteristic of learner-centred teaching. Neither is the support of one another visible as “learners quickly resort to working independently whenever an opportunity arises” (p. 32). Science teachers prefer using teaching methods that give them autonomy to dominate the teaching and learning process (Awe & Kasanda, 2016). They maintain that Namibian science teachers tend to use more teaching methods that emanate from a teacher-centred approach as compared to a learner-centred approach (p. 43). Furthermore, they recommend the provision of teaching materials and equipment to science teachers as an encouragement factor for them to use various learner-centred methods of teaching, which might promote learner participation.

3.3 South African teachers as users of science teaching approaches and teaching methods

In some education system, one can discern a mixture of perceptions where teachers appear not to have strong perceptions in favour of any of the approaches. The surveyed teachers from
South Africa have varying views on how learner-centred teaching methods in the form of inquiry-based learning can facilitate conceptual understanding of science education (Ramnarain, 2014). The rural teachers in South Africa believe that lecturing (teacher-centred teaching) “is more effective in explaining scientific concepts” (p. 72). The reasons behind this perception include the apparatuses and chemicals can easily distract learners if their prior knowledge is weak in experimental teaching methods. The second reason is the large rural classes. It is practically not easy to apply learner-centred teaching methods teaching as large class limits the teachers from active interaction with individual learners. On the other hand, the majority of urban schoolteachers have a positive perception of learner-centred teaching methods. They have a favourable view on the benefits that can accrue when using teaching methods, which emanates from a learner-centred teaching approach.

Spreen and Vally (2010), on the other hand, argue that learner-centred teaching methods have left teachers in South Africa increasingly demoralised causing them to experience tremendous stress and growing dissatisfaction with their profession (p. 48). Some surveyed teachers indicate that “the failure of learner-centred teaching methods includes time-consuming, requires many resources and teaching experiences that they do not have” (Spreen and Vally, 2010, p.51). Additionally, some teachers feel they can be more effective in teaching and producing the desired learning outcome when they use teaching methods that do not undermine their authority. Contrary to this, other researchers are attributing the failure to a range of barriers affecting the implementation of learner-centred teaching generally and specifically in science education. These include class size, shortage of teachers, lack of teaching and learning materials, poor infrastructure, and lack of parental involvement (Spreen & Vally, 2010). Furthermore, learner-centred teaching methods have not been implemented well because science teachers still teach the way they were taught, as there seems to be no practical challenge through experience.

3.4 Tanzanian teachers as users of science teaching approaches and teaching methods

In Tanzania, learner-centred teaching approach in education has caused much confusion in the teaching fraternity. “Tanzania is experiencing a severe and prolonged confusion concerning the choice of instructional or teaching methods in the education system, and especially at lower levels” (Tilya & Mafumiko, 2018, p. 1). Teacher-centred teaching methods have all along been
the preferred approach, which gave teachers much power in the dictats of teaching and learning (Anangisye & Fussy, 2014). Besides, the popularity of methods emanating from the learner-centred teaching approach, there is no evidence in Tanzania of their superiority in enhancing learning outcomes (Tilya and Mafumiko, 2018). Its applicability seems to be depressing both teachers and learners. The teachers can only “divide learners into groups to discuss a phenomenon like ‘sources of lighting’ in science education” (Mafumiko, 2018, p. 2). Because of this confusion, teachers and learners are still comfortable with the traditional way of teaching, which is ‘lecturing method’, characterised by teacher talk-and-chalk while students listen and write. Therefore, science teachers have continued to teach using teaching methods emanating from the teacher-centred approach such as lectures, demonstrations and brainstorming (Anangisye & Fussy, 2014; Tanzania Institute of Education, 2011). Furthermore, Tilya and Mafumiko (2018) list the following teaching methods which should be emphasised more in order to improve their teacher-centred teaching methods generally and in science education specifically. These are “demonstration; discussion; debate; viewing and listening; drills and practice; problem-solving; study visits, exploring nature, discovery method; laboratory work; practicum; and, role-playing. Additionally, games and singing can equally stimulate the imagination of learners; cooperative and collaborative learning; and independent study” (p. 10).

### 3.5 Summary of the theoretical framework

Science teaching must have clear goals and instruction that guides learners to engage in a pedagogical process and allows them to draw conclusions and make interpretations of scientific phenomenon. The application of teaching methods that help learners to create meaningful and understandable knowledge has the potential to develop their scientific skills (Lavonen, 2009). These methods must be “active, reflective, collaborative and interactive, constructive, cumulative and contextual” (p. 925). These characteristics of learning may be realised through inquiry activities. Teaching methods that are of learner-centred give independence to the learners as they have different learning styles. They must be encouraged to engage in guided and minimally guided inquiry-based learning as they respond to possible scientific questions (Kang & Keinonen, 2018). They must be able to draw conclusions based on scientific evidence (Lavonen, 2009, p .925).
Majority of teachers have a positive perception towards the use of inquiry-based teaching methods. These teaching methods emanate from learner-centred teaching approach and see learners as active participants in knowledge building. These methods allow learners to spend substantial time on activities that necessitates them to actively process and apply information in a variety of ways (Wieman, 2014). With the decline in learners pursuing science subjects in schools (Osborne & Dillon, 2010; Siew et al., 2015), and poor proficiency in science subjects (National Research Council, 2011), science education communities have recommended the use of teaching methods that emanate from learner-centred approaches (Kang & Keinonen, 2018). Gurses et al. (2015) state that many teachers in Turkey including science teachers still plan and prepare teaching methods that are teacher-centred. This still seems to be visible in other countries as many formal teaching practices according to (Gurses et al., 2015) are still almost entirely a teacher-led one.
4. Research task and research questions

4.1 Research task

This chapter lays out the research task and research questions. The main research task is to compare and contrast the teaching methods used by middle school science teachers in Finland and Namibia. The reasons that teachers in both countries have for preferring one teaching method to another is also explored. To this end, a case-based cross-national comparative method is used. The choice of the countries for comparison is informed by certain considerations. Finland offers a good case study as a comparator because Finland’s education has consistently ranked highly in terms of quality compared to other countries’ education systems. For example, the OECD reports rank Finland among the top performer since from the year 2000 (Bybee et al., 2009; OECD, 2010; OECD, 2016). Only recently has the top ranking gone to Singapore. In regard to science education specifically, Finland has been ranked among the 5 top ing countries in the Organisation for Economic Co-operation and Development (OECD). In Namibia on the hand, lack of data relating to the ranking of the education system, in general, makes it hard to compare how well the Namibian education system performs in comparison to others. However, the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SAQMEC) revealed that:

“Namibia has the third-best improvement in rates in reading and mathematics among the 13 participating countries. It has an increase in learner performance of more than 40 points for both reading and mathematics across the country” (Nakashole, Auala, Amakutuwa, Ailonga & Shigwedha, 2017, p. 114).

The success of Finland’s education system has been credited to a number of factors (Maes, 2012). Generally, the availability of sufficient resources that are equitably distributed across schools is one of the main reasons for this success. A 2013 UNICEF report identified lack of resources as one of the factors that undermine the quality of primary and junior secondary education in Namibia (UNICE, 2013). Furthermore, whatever resources that are available it seems that they are not distributed equitably. According to the national institute for educational development report on the teachers’ needs, it reviewed that “many teachers found the lack of materials and resources in schools as an obstacle” in using and implementing some teaching methods (MoE, 2009, p. 39). There is a strong contention that many schools, especially in rural areas, lack sufficient classrooms, essential physical facilities such as libraries, laboratories and
technical facilities (MoE, 2011). The lack of resources especially the teaching materials affects the teaching and learning process negatively. Well-resourced schools, especially in urban areas, tend to perform better on average compared to some rural schools where learners and teachers struggle in using the scarce teaching materials (p. 92).

Finland’s education system is distinguished due to well-qualified teachers. (Ministry of education and culture, 2017). The reason behind the good qualification is mainly due to the fact that teachers in Finland are required to have a minimum of a master’s degree to qualify to teach. Only the highest qualified candidates are selected to train as teachers. The teacher-training curriculum is extensive and is tailored to (Ministry of education and culture, 2017). In contrast, the qualification of teachers in Namibia is undermined by a variety of factors. Firstly, teachers are only required to earn a 3-year diploma to qualify to teach. The teaching career is not a highly esteemed profession compared to Finnish teaching career thus it fails to attract the highly qualified (Ottevanger et al., 2007).

While the differences seem stark, the education systems of the two countries share some commonalities. One of the commonalities has to do with the teaching approaches used in both countries. The education systems are tailored around the learner-centred teaching approach. Additionally, in both countries, education takes up a considerable percentage of their Gross Domestic Product (GDP). Education has been taking the highest percentage of the Namibian national budget since independence in 1990 (UNICEF 2017 while Finland spends significantly on education (Andere, 2015) and the comprehensive school education took up the most significant share of current expenditure on education. Both countries demonstrate a perception of the importance of education by making education free. In Finland education is free at all levels from pre-primary to higher education and from pre-primary to junior secondary is mandatory while in Namibia, formal basic education is free and compulsory (Ministry of education and culture, 2017; National Curriculum for Basic Education, 2016)

The combination of the differences and similarities that exists between the educational systems of these two countries provide a rich background for a cases-based cross-national study focusing on teaching methods in science. Further, it is also useful in setting the stage for an investigation as to why teachers in both countries prefer certain methods of teaching over others. This study fills a gap in knowledge to the extent that no similar study on this issue has been undertaken before. The findings of this study will form the basis of recommendations on
suitable science teaching methods for teachers in both countries and science teacher generally. The findings could be relevant for designing education reform both in Namibia and in Finland aimed at improving the manner in which science is taught in junior secondary schools. The following section outlines the research questions that guided this inquiry.

### 4.2 Research questions

This study intends to identify, compare, and contrast the preferred Middle school science teaching methods in Finland and Namibia. The analysis of the reasons behind the preferences can provide science teachers with an alternative and overview of their teaching methods. The research task as explained, informed the research questions that have guided the study.

1. **What kind of perceptions the teachers have about the science education:**
   1.1 How do Finnish middle science teachers perceive their science education?
   1.2 How do Namibian middle science teachers perceive their science education?

2. **What are the science teaching methods teachers’ use in Finland and Namibia:**
   2.1 What are the science teaching methods used by Finnish middle school science teachers?
   2.2 What are the science teaching methods used by Namibian middle school science teachers?

3. **What are the reasons behind the preferences of the teaching methods:**
   3.1 What are the Finnish middle school science teachers’ reasons behind the preferences of the teaching methods?
   3.2 What are the Namibian middle school science teachers’ reasons behind the preferences of the teaching methods?

4. **How do teachers asses the implementation of science teaching methods:**
   4.1 How Finnish middle school science teachers assess the implementation of science teaching methods?
   4.2 How Namibian middle school science teachers assess the implementation of science teaching methods?
5. The methodology of the study

This chapter lays the whole process of how the researcher conducted the study in pursuit of answering the research questions. A case-based cross-national comparative approach was applied which followed a social constructivism research paradigm as the ontological belief that best suits its purpose. The researcher has described what qualitative research is and explained the meaning of case-based cross-national comparative study within the qualitative research designs. Additionally, well-crafted research design is provided; it details a systematic process the researcher followed from the inception of the topic to the results of the study. The researcher equally has provided the participants’ details. A planned interview protocol for data collection and a summary of how data were collected have been similarly provided. The chapter ends with the detailed data analysis procedure, which in this case was content analysis.

5.1 Social constructivism research paradigm

This study adopts social constructivism as the operating paradigm. Social constructivism is often distinguished from other paradigms such as positivism, realism, essentialism among others. In a social constructivism research paradigm equally referred to “as interpretivism paradigm” (Creswell & Poth, 2018; p. 24), the researcher proceeds from the assumption that meaning is socially constructed and the process of constructing meaning is fluid. In social constructivism, much reliance on understanding the worldview is placed on the situational-views of participants (Creswell & Poth, 2018). These views are usually negotiated in social and historical context and moulded through the interaction of individuals hence, “social constructivism” (Livesey, 2011b). Individuals develop subjective meanings of their experiences, which focuses on certain objects or things as they seek understanding of the world they live in. The explanations thereof come in different and multiple ways, which forces researchers to expand their worldview as opposed to constricting the meanings into few classifications or concepts (Creswell & Poth, 2018). A researcher who uses a social constructivism approach seeks answers to questions of, “what kind of things individuals do, how and why they do such things, and for what purposes” (Creswell and Poth, 2018, p. 24).

Researchers argue that objective observation of the social world is impossible because it is full of meanings created and recreated subjectively by our actions and conducts. Henceforth, social constructivism is an approach that views a situation as something that is relative and can only
be constructed and reconstructed daily. Individuals with their diverse experiences, expectations, and skills contribute to the on-going construction of reality existing in their broader social context through social interaction. Therefore, knowledge is established, and theories are built through developing concepts from observed and interpreted social constructions which the researcher seeks to make sense of (Vosloo, 2014; Wahyuni, 2012). Thus, individuals are relatively the measure of truth for a moment, something that can change later according to a different contextual setup that can arise.

The benefits of social constructivism for the researcher are that it allows the researcher to set aside preconceived notions and assumptions about the meanings of concepts. Consequently, the researcher is able to overcome the limitations of her/his bias and maintain neutrality. Furthermore, because social constructivism assumes that meaning is constantly changing, the researcher proceeds with the knowledge that whatever meaning she/he discovers is provisional. It should remain as such and subject to revision upon the discovery of newly formed meaning. The highlighted characteristics of social constructivism have its choice as the operating paradigm of this research.

The social constructivism paradigm informed this research in a number of ways. Firstly, the use of interviews served to inform the researcher about the different perceptions that science teachers in Finland and Namibia have regarding their teaching methods. This approach allowed the researcher to overcome any preconceived notions about the two systems that may have accrued from reading the relevant literature. Therefore, social constructivism approach aided the researcher in uncovering the preferences of teaching methods as Middle school science teachers were carefully interviewed.

Secondly, the researcher chose to use the qualitative research method. The qualitative research is usually referred to as interpretive research because it allows researchers to understand a given phenomenon; in this study the teaching methods of science teachers in Finland and Namibia. The interpretation of the results considered the social and cultural context of (Finland and Namibia) as well as considering the meanings the teachers gave to the phenomena. The choice of the qualitative methodology of the research is explored further in the following section.

Overall, the use of social constructivism in this research shows that the importance of this study is relative to the lived-experiences of science teachers rather than generalised opinions.
Therefore, the researcher gathered the information by talking to the participants directly and seeing them within their context. Accordingly, individual science teachers were interviewed in naturalistic settings at the site where the participants experience the issue under study (Creswell & Poth 2018, p.43). For this study, social constructivism helps the researcher to identify the preferred teaching methods of middle school science teachers and the reasons behind the preferences. Additionally, their perception of science education; and the assessment of the implementation of their teaching methods were similarly investigated. This consideration enables the researcher to interpret and analyse the data gathered in a way that helps the readers to understand the phenomenon studied.

**Qualitative research methodology**

Creswell and Poth (2018) describe qualitative research as an approach that proceeds without a pre-existing hypothesis. Qualitative researchers use qualitative approaches to inquiry and data collection in an ordinary setting; while being careful to maintain the anonymity of the people and places under study. They apply data analysis that is both inductive and deductive to establish patterns or themes. Therefore, the final written report or presentation comprises of the voices of the participants, the researcher’s elaborate description and interpretation of the problem as a contribution to the literature (Creswell & Poth 2018). Natural setting entails the sites at which the research takes place as the researcher conducts his or her research in the field acquainting himself/herself face-to-face with the participants. This study has been in junior secondary schools of Finland and Namibia. In all, four schools were involved of which three are Namibian schools. Qualitative research aims at the understanding of some aspects of social life. It is a research approach that does not measure through experiments. It instead emphasises the qualities of entities and on processes and meanings (Denzin & Lincoln, 2008).

**5.2 Comparative study design: Case-based cross-national comparative study**

Comparing is a fundamental mental activity that occurs in natural and straightforward ways in everyday lives by comparing aspects between phenomena (Flick, 2014). It takes place more complexly as a set of standard practices that focuses on the relations between phenomena. Thus, mostly, comparison with or without intention guides our reasoning (Flick, 2014). This cross-national research seeks to extend understanding of the studied phenomenon (science teaching methods) by comparing and contrasting the phenomenon from different perspectives
(Ligozat et al., 2015). In this regard, teachers’ preferred teaching methods; the reasons behind the preferences; their perceptions of science education; and, assessment of the implementation of the teaching methods.

Accordingly, this research follows a case-based cross-national comparative study where Finland becomes a case and Namibia another case (Vaus, 2008). Vaus, (2008) argue that cross-national comparative research is a study that describes, explains the cross-national similarities and differences. It compares nations on some measurement, in this case, the preferred teaching methods of science teachers. The case-based cross-national comparative approach seeks to understand the elements of a country (case) within the context of the whole case. In this case, “the ‘whole case’ is superior to the parts, and the parts cannot be understood without reference to the whole” (Vaus, 2008, p. 252). Therefore, the researcher has to understand the phenomenon independently before studying it holistically as two cases of Finland and Namibia. As Vaus, (2008) argues, it adopts a cultural and interpretive model in that any behaviour, attitude or indicator can only be understood within its historical, cultural and social context. Hence, a rounded understanding of each country is constructed regarding the phenomenon under study. Each case (country) is treated as a unit that warrants to be understood as a coherent whole.

Cross-national comparative research has the potential of bringing together a collection of different classroom realities that take place from different teachers when executing the curricula (Ligozat et al., 2015). It can provide a better understanding of classroom practice of science teachers in two countries. The comparative research investigates the nature of pedagogical practices as a set of human actions that are intentionally organised towards the transmission of a socially legitimated culture (Ligozat et al., 2015; Ligozat, 2011). For the purpose of this study, the culture is science education.

Comparative investigations have the potential of opening up debates within the international community of educational researchers who have a common interest in pedagogical research that focuses on the teachers’ professional practices (Ligozat et al., 2015). Just as Ligozat (2011) argues, the comparative study provides a set of knowledge which could serve as a basis for carrying out comparisons of practices across institutional settings (p. 8). Thus, the knowledge collated can be of relevance to stakeholders other than educational researchers.
Adopting a comparative approach enables a researcher to shed light on the practices taking place in the cases being compared (Marty, Venturini & Almqvist, 2018). Specifically, comparison research analyses common and specific trends in a phenomenon under investigation (Marty et al., 2018). It allows researchers to step back from their cultural references and have a different perception of the phenomenon in the light of the “new research findings” (p. 56). This study has shed light on the similarities and difference of Finland and Namibia education system by investigating teaching methods; reasons for the preferences; perceptions of science education; and implementation of teaching methods in the two countries. The challenge that comes along with case-based cross-national comparative research is that countries differ in many ways. It is impracticable to compare every possible characteristic of two countries as the differences range from the historical, cultural, and social context, and, the level of education. As such, the comparison may not be able to uncover all the similarities and differences that relevant to given research questions. This research proceeds against the acknowledgement of this possible limitation.

5.3 The research design of the study

Burke and Christensen, (2014) describe a research design as a plan of systematic procedures a researcher follows. It starts from the conceptualisation stage, data collection, the analysis of data in answering the research questions to the reporting stage. It details the methods that the researcher used to collect data in order to answer the research questions. It further stipulates how the data is to be analysed and interpreted. This research was carried out in three phases of data collection. The first phase was a pilot phase. In this phase, 5 Namibian students studying in Finland were interviewed. The importance of this phase was to test the research instrument and to determine whether and how it could be adjusted. The pilot phase sought to incorporate the suggestion made by (Burke and Christensen, 2014) that “it is a cardinal rule in research to try out or pilot-test your research instrument before using it. It enables the researcher to determine whether the instruments operate properly” (p. 212). Following the pilot phase, data were collected from Finland. Here, 8 science teachers were interviewed. Then, 8 science teachers from Namibia were also interviewed. Of the 8 Namibian science teachers interviewed, 4 were from two rural schools and the other 4 from 1 urban school. Figure 1 below illustrates the whole process from the conceptualisation stage to the reporting stage of the study.
The research participants

Twenty-one qualified teachers participated in this study. 5 participants participated in the pilot project. These are Namibian science teachers studying towards their master’s degree in Finland. Of these 5 participants, 3 were female teachers and 2 male teachers. In the data collection stage, there were 8 participants from Finland of which 5 were female teachers, and 3 were male teachers. From Namibia, there were equally 8 participants of which 4 were from 1 urban school, and the other 4 were from 2 rural schools. From the urban school, 3 were male
teachers and 1 was a female teacher and those from the rural schools, 2 were male teachers, and 2 were females.

The distribution of male and female participants was not balanced within each sample. The gender representation was as follows: Finnish sample, they were 5 female teachers and 3 male teachers. Namibian sample, they were 5 male teachers and 3 female teachers. Tables: 6, 7, and 8 below show details of the participants, which includes gender, qualification, school phase at which they are teaching and their total teaching experience.

**Table 6: Participants' information: pilot stage**

<table>
<thead>
<tr>
<th>Pilot Participants</th>
<th>Gender</th>
<th>Highest Education Qualification</th>
<th>Phase Teaching experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1</td>
<td>Male</td>
<td>B.Ed. (Geography)</td>
<td>5 – 10</td>
</tr>
<tr>
<td>ST2</td>
<td>Male</td>
<td>B.Ed. (Primary Education)</td>
<td>5 – 10</td>
</tr>
<tr>
<td>ST3</td>
<td>Female</td>
<td>B.Ed. (Maths &amp; Science)</td>
<td>5 – 7</td>
</tr>
<tr>
<td>ST4</td>
<td>Female</td>
<td>B.Ed. (Maths &amp; Science)</td>
<td>5 – 7</td>
</tr>
<tr>
<td>ST5</td>
<td>Female</td>
<td>B.Ed. (Maths &amp; Science)</td>
<td>5 – 7</td>
</tr>
</tbody>
</table>

Note: (ST = Student Teacher)

**Table 7. Finnish participants' information: data collection stage**

<table>
<thead>
<tr>
<th>Participants</th>
<th>Gender</th>
<th>Highest Education Qualification</th>
<th>Grades</th>
<th>Teaching experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT1</td>
<td>Female</td>
<td>M.A (Maths Physics &amp; Chemistry)</td>
<td>7 – 9</td>
<td>10</td>
</tr>
<tr>
<td>FT2</td>
<td>Male</td>
<td>M.A (Geography &amp; Biology)</td>
<td>7 – 9</td>
<td>23</td>
</tr>
<tr>
<td>FT3</td>
<td>Female</td>
<td>PhD (Mathematics)</td>
<td>7 – 9</td>
<td>25</td>
</tr>
<tr>
<td>FT4</td>
<td>Male</td>
<td>M.A (Physics, Chemistry &amp; Maths)</td>
<td>7 – 9</td>
<td>15</td>
</tr>
<tr>
<td>FT5</td>
<td>Female</td>
<td>M.A (Geography &amp; Biology)</td>
<td>7 – 9</td>
<td>25</td>
</tr>
<tr>
<td>FT6</td>
<td>Female</td>
<td>M.A (Geography &amp; Biology)</td>
<td>7 – 9</td>
<td>10</td>
</tr>
<tr>
<td>FT7</td>
<td>Female</td>
<td>M.A (Maths, Physics &amp; Economics)</td>
<td>7 – 9</td>
<td>3</td>
</tr>
<tr>
<td>FT8</td>
<td>Male</td>
<td>M.A (Maths, Physics &amp; Chemistry)</td>
<td>7 – 9</td>
<td>25</td>
</tr>
</tbody>
</table>

Note.

*FT = Finnish Teacher*

In the Finnish context, Junior phase = grades (7 – 9).

*M.A = Master of Arts (Education)*
### Table 8. Namibian participants’ information: data collection stage

<table>
<thead>
<tr>
<th>Participants</th>
<th>Gender</th>
<th>Highest Education Qualification</th>
<th>Grades</th>
<th>Teaching experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT1</td>
<td>Male</td>
<td>B. Ed (Education Management)</td>
<td>8 – 10</td>
<td>10</td>
</tr>
<tr>
<td>NT2</td>
<td>Female</td>
<td>BETD + (ACE in Learner Support)</td>
<td>7 – 10</td>
<td>20</td>
</tr>
<tr>
<td>NT3</td>
<td>Female</td>
<td>BETD + (ACE in Geography)</td>
<td>8 – 10</td>
<td>8</td>
</tr>
<tr>
<td>NT4</td>
<td>Male</td>
<td>B.Ed. (Educational Management)</td>
<td>8 – 10</td>
<td>17</td>
</tr>
<tr>
<td>NT5</td>
<td>Male</td>
<td>Dip (Maths &amp; Science)</td>
<td>8 – 10</td>
<td>12</td>
</tr>
<tr>
<td>NT6</td>
<td>Male</td>
<td>B.Ed. (Educational Management)</td>
<td>8 – 10</td>
<td>11</td>
</tr>
<tr>
<td>NT7</td>
<td>Male</td>
<td>BETD + (ACE in Geography)</td>
<td>8 – 10</td>
<td>17</td>
</tr>
<tr>
<td>NT8</td>
<td>Female</td>
<td>B.Ed. (Maths &amp; Science)</td>
<td>8 – 10</td>
<td>7</td>
</tr>
</tbody>
</table>

**Note.**

**NT** = Namibian Teacher

In the Namibian Context, Junior Phase = (8 – 9). (Science = Physics, Chemistry & Life Science).

**BETD** = Basic Education Teachers Diploma. **ACE** = Advanced Certificate in Education **B Ed** = (Bachelor of Education Honours degree).

Regarding teaching experience, the samples included teachers with differing levels of experience. In this investigation, teachers having one to five years of teaching experience were described as beginner educators; those having five to ten years of teaching experience were described as experienced educators. Those with ten years of experience or more were described as expert educators (MoE, 2009). In the Finnish sample, one was a beginner educator; two were experienced educators, and five were expert educators. In the Namibian sample, three were experienced educators and five were expert educators.

### 5.4 Interviews as a data collection method

An interview is a data-collection tool in which an interviewer (researcher) asks an interviewee (research participants) a list of questions. These questions are developed in accordance with the research questions and objectives (Burke & Christensen, 2014). The researcher then collects the data mainly through an audio recorder as the participants (interviewee) responds to a set of questions. If an interview is well carried out, it enables the participants to share their perspectives, stories, and experiences about a particular social phenomenon of interest to the researcher. Participants pass on their knowledge to the researcher through the conversations held during the interview process (Burke & Christensen, 2014). In this research, the interview questions used were formulated in reference to the research questions and a semi-structured
interview approach was implemented. The participants responded to a set of questions following a comprehensive interview protocol instrument, which was divided into three parts. The first was about building a rapport and background information of the participants; then followed by their perception towards science education and experiences. The last part was about the school context and their preferred teaching methods.

A planned interview protocol was used as a data collection tool. Issues covered in the interview were specified in advance in an outlined format. This type of interview allows the researcher to come to the interview session with a planned interview protocol, which is a guide on how to explore the topics of interest. Even though researchers are free with the order of how the questions can be posed, they must not drift from the focus and the objectives of the process. During the interviews, the interviewer modified the sequence and the wording of the questions according to the participants’ responses and the interviewer judgement. In some cases, the interviewer rephrased the questions to allow the participants to understand the scope of the questions. These modifications were not of a substantive nature as to alter the pre-determined scope of data collection.

Semi-structured interview approach allows for flexibility. The interviewer was able can make a follow up on issues that diverge from the guide because of the open-endedness of the responses of participants. This allowed the researcher to maintain the objective of the research, which was to understand science education and teaching methods from the perspective of the participants rather than generalising their viewpoints (Burke & Christensen, 2014).

The interviews were done face-to-face. This allowed the researcher to use probing statements for more clarity and to obtain more information (Creswell & Poth, 2018). Even though often longer, face-to-face interviews are more productive in elucidating nuances and obtaining detailed information (Burke & Christensen, 2014). Additionally, an interpersonal encounter allowed the researchers to establish a rapport with participants. It further allowed participants to be-at-ease before engaging in conversation that is more detailed. Interviews help researchers to assess how informative the interviewee might be about the subject in question. As argued by Giorgi (2009) and Englander (2012), through interviews, researchers are able to obtain a more comprehensive description of the phenomenon because they get to hear it first hand from the participants.
This approach helps researchers to develop a literature of less researched topics and have a better understanding of the topic under consideration. However, semi-structured interviews produce open-ended qualitative data, which requires more time for analysis. To address this potential drawback, the researcher recorded and listened carefully to audio recording and read the verbatim transcripts repeatedly while noting and summarising essential points and patterns.

5.5 The data collection process

The data collection process involved several stages. This section describes these stages and explains how ethical considerations were taken into account in each of them. The location sites and participants were to be schools and science teachers in Finland and Namibia. The primary ethical consideration at this stage was the need to obtain permission from relevant authorities in order to carry out research. In this case, permissions were required from the director of education in Joensuu Finland, and the directors of education in the Oshana region and Ohangwena region in Namibia. Once permissions were obtained, the researcher selected particular sites from which the target group or participants would be sought. The selection of these sites was informed by the researcher’s familiarity with these regions. Furthermore, permissions were duly sought and obtained from the school principals in the selected schools in both countries.

For the purpose of data collection, the site refers to schools selected purposefully as they were all junior secondary schools. The participants were also purposefully selected as they were all science teachers in those schools. Participants in both Finland and Namibia were middle school science teachers. This selection of particular schools was purposeful as the target was junior secondary schools. Even though the selection was purposeful, the researcher maintained no biases about preconceived characteristics of schools or participants as the target was only Middle school science teachers. To build rapport with the schools and teachers, the researcher arranged informal meetings with the teachers. This was done with the help and intervention of the respective principals. At these informal meeting, the target groups were informed of the nature, scope, and goals of the research and asked to volunteer as participants to be interviewed. This ensured that those who were eventually interviewed participated voluntarily in the process. Each participant who agreed to volunteer scheduled time for the interviews that were convenient to them. The researcher avoided dictating the dates and times that, the interviews were conducted.
During the interviews, the researcher made a point of *building a rapport* to ensure the interviewees were put at ease. For example, the researcher maintained a jovial composure throughout the interviews and gave copies of the interview protocol to every participant before the commencement of the interview. Before the interview occurred, the researcher explained to the interviewee that they were free to decline to answer any questions that they considered inappropriate. Additionally, the interviewer informed the interviewees that their identity would be protected by a measure taken to ensure anonymity see appendix A. The researcher similarly sought and obtained permission for voice recording from each interviewee. An explanation was given that the data collected was to be used only for preparing the researcher’s thesis. Participants were equally informed that the data would be *stored* in the recording device Olympus WS-801. Later transferred to the researcher’s computer hard drive and in a portable USB storage device for safety reasons See Figure 2 below. The collected data would be destroyed as soon as the thesis was published. The duration of the interview was approximately

**Figure 2. The data collection circle**

40 minutes.

Adapted from: (Creswell & Poth 2018, p. 149)

In any profound research, the information about peoples’ conceptions of a given phenomenon is better obtained from their speeches and actions (Alshenqeeti, 2014). Thus, semi-structured
interviews are best suited for comprehensive data collection because of their “open-endedness” (p. 40). During the interviews, the participants were persuaded to speak freely about their teaching methods, perceptions, and experiences of science education. Henceforth, allowed them to give concrete examples instead of superficial descriptions of their teaching methods, experiences and perceptions of science education. Data from Finland was collected in March 2018 whereas the Namibian data were collected in April 2018, respectively. The whole sample involved four schools in total, one in Finland and three in Namibia. In Finland, one school that responded positively to the request of data collection was enough to provide the needed sample of eight teachers. In Namibia, all the three schools responded positively; which comprised of two rural schools in the Ohangwena region and one urban school in Oshana region. The first rural school had only two science teachers that were willing to participate. Therefore, two more teachers were needed to have the required sample of four participants from rural Namibia. This necessitated the researcher to go to a second rural school.

5.6 Content analysis procedure

Content analysis is one of the procedures that qualitative researchers can use to analyse textual data. Moretti et al. (2011) describe content analysis as a method used to classify written and/or oral materials into identified categories of similar meanings. These materials include narrative responses, open-ended survey questions, interviews, focus groups, observations, and printed media such as articles, books, and/or manuals. The categories can represent either explicit or inferred communication with the goal of providing knowledge and understanding of the phenomenon under study. In this case, knowledge was sought about the teaching methods in science education in Finland and Namibia.

In this study, a qualitative content analysis approach has been used to analyse the data obtained from the interviews. Sándorová, (2014) argues that content analysis involves a process that “reduces the raw data into smaller groups of information” (p. 96). These groups are referred to as codes, categories, or themes. Thus, the analysis summarises and interprets written data in a narrower context and further examines and verifies the written content. Qualitative data were collected using semi-structured interviews. The data was later transcribed for direct quoting and coding using the Atlas.ti 8 software programme. The transcribed Finnish data produced 36 pages and the Namibian data produced 43 pages. The codes were then grouped into different categories guided by the research questions. Figure 3 below illustrates the process of qualitative analysis.
content analysis used in this study. A simple step by step that shows how the data were organised. Interview data were transcribed and then coded by the researcher. Codes according to Hennink, Hutter & Bailey (2011) are vital topics discussed by participants and identified by the researcher by reading the data.

Figure 3. The stages in qualitative data analysis

Codes make it easier for researchers to search through the data, make comparisons, and, identify patterns that require further investigation. After coding, the data can then be grouped into categories. According to Creswell (2013) “categories equally referred to as themes”, are a wide-ranging unit of information that consists of several codes accumulated to form a collective idea (p. 186). Thus, categorisation is the logical process of arranging these extensive units of data into groups with similar features (Taylor & Lindlof, 2011). It is from these categories that themes were constructed in the presentation of the data. These are (1) Finnish middle school science Teachers’ perceptions of science education and, (2) Namibian middle school science teachers’ perceptions of science education. (3) The science teaching methods used by Finnish middle school science teachers and, (4) the science teaching methods used by Namibian middle school science teachers. (5) Finnish middle school science teachers’ reasons behind the preferences and, (6) Namibian middle school science teachers’ reasons behind the preferences. (7) Finnish middle school science teachers’ assessment of the implementation of science teaching methods and, (8) Namibian middle school science teachers’ assessment of the implementation of science teaching methods. The result section is presented based on these categories.
5.7 Validity and ethical issues of the methodology

To validate the methodology of a study, a researcher must make use of the four criteria of trustworthiness namely credibility, transferability, dependability, and confirmability. The implementation of these criteria in the data collection process helps the researcher to construct a deep understanding of the perspectives of the participants. The researcher can have a better understanding that emerges from the prolonged immersion in the participants’ social worlds according to how the research instrument has been designed. The researcher is further required to demonstrate the participants’ social context of participants by producing good descriptions from the collected data. In this study, the research has interpreted the data with the caution of knowing that the data contains the subjectivity of the respondents’ views. Therefore, the methodology can be deemed credible if the researcher abides by and maintains the ethics during the data collection process.

Creswell and Poth (2018) discuss three ethical guidelines for qualitative data collection process. These are respect for persons, (that is privacy and informed consent), concern for welfare (that is minimising possible harm and argument reciprocity), and justice (that is equitable treatment and enhance inclusivity) (p.151). Respect for persons demands the researcher to inform the participants about the overall purpose of the research, as well as of any possible risks and benefits from participation. It includes gaining their voluntary participation rights and or to withdraw at any time if need be. Respect for persons is not entirely problematic but requires a researcher to follow the whole communication procedure of the school before finally collecting data. In this case, permissions to conduct research and collection of data from either country was done through the educational directors. In Finland, permission was granted from the Municipality of Joensuu educational director whereas; in Namibia, permission was granted from Oshana and Ohangwena educational directors respectively. This was followed by permissions from the school principals and lastly, individual participants’ consents.

All the participants starting from the piloting stage to the actual data collection participated voluntarily without any form of persuasion. When providing the objectives of the research to the participants, the ethical research statement that informed them of their right to consent participation was also provided. This was done first in the requisition letters, for permission and at the beginning of each interview. Balancing between giving too much information and leaving out some aspects of the design was necessary. The target was to obtain the teachers’
natural views of the topic and avoid giving them cues that could lead them to specific answers. In this study, private information that could identify the teachers and their schools have been excluded; this includes features like participants’ names and ages as they were wholly excluded from the questionnaire.
6. Results and discussions of the study

In this chapter, the findings of the research are presented according to the format of research questions. This is followed by detailed discussions of each presented segment of the findings making the results to be integrated with the discussions. The teachers’ perceptions of science education are presented first, and then the teachers’ preferred teaching methods and the reasons behind the preferences follows. Lastly, the teachers’ assessment of the implementation of the teaching methods is presented and discussed.

6.1 Science education: Middle school science teachers’ perceptions of science education

The first research question of this research aimed to identify the teachers’ perception of science education in both countries. The researcher considered the teachers understand what science education is because they are all qualified. Therefore, teachers were asked to explain the concept of science education and what it means to them. Teaching science can be influenced consciously or unconsciously by the teachers’ perceptions of science education. These perceptions are presented in the next sections per country.

6.1.1 Science education: Finnish middle school science teachers’ perception of science education

The importance of teaching science in Middle school

Finnish middle science teachers argued that it is imperative to teach science because it is the base of every human action. It is easy to relate what is taught to what is happening in real life. This allows learners to connect between real-life events and theories. Majority of the respondents argued about the importance of using phenomenon-based teaching.

*It allows learners to understand easily the link between theory and activities that includes examining the interaction of man and nature (FT1).*

Science subjects are experimental subjects, therefore, doing experiments leads learners to learn how to discover new knowledge and prove scientific theories. As argued by the respondents that:

*Science education is essential for innovative skills (FT1).*
It motivates them to learn theories, develop new ways of doing things and think scientifically. In return, it provides an atmosphere where learners get motivated to understand what they are learning. For instance,

*Science education allows every citizen to comprehend why solar energy and wind energy are better alternatives to fossil energy. It makes us see the need to control the plastic problem in our oceans (FT7).*

Therefore, basic scientific knowledge arouses the interest and motivation that can help learners mature with the sense to care for the environment. Science broadens learners’ views and thinking in a way that prepares them to manage society in the future.

**Teaching goals in Middle school science education**

Almost all the respondents argued that understanding basic science and the nature of science is vital in middle school science education. They argue that:

*It enables learners to develop the sense of relation towards nature and the interdependence we have with it. Learners need to develop the working skills way early during their middle school years before proceeding forth to high/vocational school (FT5).*

Almost half of the respondents (FT1, FT3 & FT8) argued that it is at the middle school where learners need to acquire and develop skills in handling and to use laboratory equipment. This can eventually prepare them for careers in scientific fields. Additionally, science education is needed for lifelong learning as it makes learners think outside the box.

*Teaching science leads learners to relate theory to real life situations and to be able to explain and explore the scientific phenomenon. This can potentially lead to the creation of a scientifically literate society that can export knowledge (FT8).*

FT6 stated that teaching science makes learners develop skills on how to ‘learn best’ and use those skills later in life.
According to FT2, science teachers must be able to make learners develop an interest in science by getting more information on how to study science especially (Geography and Biology). Eventually, this can boost their motivation and enable them to aspire for exceptional achievement in science education. Hence, giving learners more activities allows them to work harder, stretches their zone of proximal development and ultimately realise their academic potential.

**Co-teaching and co-planning among Finnish middle school science teachers**

Teamwork seems to be one of the pillars that makes Finnish education system to be competitive. Almost all the respondents except (FT3) indicated that they usually do co-teaching and co-planning for their respective subjects. See Figure 4 below.

![Figure 4. The views of Finnish middle school science teachers towards co-teaching and co-planning](image)

We do co-planning mainly every week. We talk about how we can develop our teaching and share our materials and ideas. Should any colleague have any better idea for some lab work or something else, we are willing to share those ideas (FT1). The biology teachers are the nearest colleagues, and we have been planning much together. Physics chemistry and geography teachers equally plan together. Therefore, cooperation and communication among colleagues is our strength (FT2).

Therefore, teaching science education can be enhanced when teachers co-teach and/or co-plan as different shared perspectives are recommendable for the success of science education.
Finnish middle school science teachers’ perception of the revised curriculum

The central philosophy in the revised curriculum is lifelong learning that motivates learners to become active learners who are eager to develop and acquire new knowledge. Respondents argued that the revised curriculum encourages cooperative learning and demands teachers to improve the learning skills of learners and have consideration of learners’ individualism. It emphasises learning based on the phenomenon, demands a lot from learners and encourages them to learn in groups by doing experiments. Some respondents argued that striking a balance in the delivery of the curriculum content is needed between working in groups and individualised work for learners.

Doing everything in groups will allow the weak learners not to be fully engaged in learning. (FT7), equally, doing everything individually would not prepare learners for working life (FT1).

The revised curriculum which advocates for phenomenon-based teaching approach is more detailed. It has on the other hand reduced time allocation for practical work and implementation of phenomenon-based teaching. Some respondents stated that time allocation for science subjects had been reduced.

Biology and Geography have seen its time reduced to one-hour per week is quite small. More priority has been given to Arts, physical exercises and home economics (FT2).

The subject content of some subjects seems to have been reduced in the revised curriculum as compared to the old curriculum. FT3 complained that topics in Physics like Electricity; Magnetism; Force and Light have had the content reduced. On the other hand, the respondents stated that the revised curriculum had seen improvement in assessment formats which includes allowing learners to explore phenomena as the teacher guides and mentors them has been added.

6.1.2 Science education: Namibian middle school science teachers’ perceptions of science education

The importance of teaching science in Middle school

Namibian middle school science teachers argued that middle school science prepares learners for future careers as scientists according to the national curriculum stipulation.
Science education is interesting because learners learn from facts with hands-on that allows them to explore things on their own by touch, feel, smell, hear and see (NT4). Therefore, science education empowers learners with the knowledge about what is going on in our environment and enables them to connect reality and theory.

Science education educates learners about the environment and at the same time learn about weather patterns. Learners develop skills like how to record and present information (NT7). Science education especially life science educates learners about different diseases that affect human beings. Therefore, exposing learners to science education gives them knowledge of how to exercise healthy living habits. (NT2).

Some respondents especially those teaching Physical science argued that doing experiments enhances the scientific skills of learners. According to (NT4), these acquired skills eventually can be demonstrated when learners start carrying out their scientific investigations as they participate in science fairs.

The act of producing new results in experiments makes learners to develop a positive attitude in science education. Therefore, their interest as well develops because they want to touch those apparatus and see what happens after experimenting (NT5).

Teaching science education through experiments and demonstrations can potentially improve the performance of learners in the science subjects.

**Teaching goals in science education in Middle school**

Almost all the respondents stated that the main aim of science education is in line with Namibia national vision 2030. That, the acquired scientific knowledge should enable learners to be participants in transforming Namibia into a knowledge-based society. In this acquired scientific knowledge, (NT1) stated that:

Learners should have the scientific skills to handle various challenges in their environment. For example, the caution of too much clearing of land, which may lead to soil erosion, fewer crops production, deforestation, flash flooding and increased greenhouse gases (NT1).
These human activities have the ability to contribute to global warming and other negative social aspects. According to (NT4), the most important thing is to teach learners to have an understanding and knowledge of basic science.

Basic knowledge of science education prepares learners for life in society and after school and not necessarily preparing them for examinations (NT4).

Science education trains middle school learners to have an understanding of why and how things are happening in nature.

It allows learners to discover things as opposed to being told through narratives and stimulates the development of inquiry and inquisitive minds about the nature around us (NT4).

This leads to the acquisition of scientific skills and knowledge that has to be built on their prior knowledge to solve our societal problems. Subsequently, develop into a people that make informed decisions based on scientific evidence. Learners can then be able to communicate with others and progress to the next phase of education with good performance, which might eventually lead them to have careers in scientific fields.

Co-teaching and co-planning among Namibian middle school science teachers
At least more than half of the respondents stated that they usually do co-planning and half of the respondents usually do co-teaching. See Figure 5 below.

![Figure 5. The views of Namibian middle school science teachers towards co-teaching and co-planning](image-url)
NT5 argued that co-teaching is mainly applicable when a specific teacher has a problem with the contents of some specific topics. He/she can then invite another teacher of similar expertise for help. However, the majority were of the view that co-teach and co-plan is a way of helping each other in planning lesson plans and lesson execution.

Co-teaching is quite useful because sometimes a teacher might overlook some contents when teaching which a colleague can highlight (NT6). Furthermore, there are sensitive topics like reproduction in Biology/Life science, which makes learners shy if it is only one teacher teaching, but they become more proactive when a second teacher is present (NT2).

Co-planning or discussing with a colleague helps in situations when the understanding of some concepts becomes challenging and together develop teaching strategies that can benefit both the teachers and learners. As demonstrated in Figure 5 above, the majority of the respondents favour co-planning. Therefore, co-teaching and co-planning could be recommended acts for teachers.

**Namibian middle school science teachers’ perception of the revised curriculum**

The majority of the respondents had positive views towards the revised curriculum even though; some indicated that it came with some shortcomings. They argued that the revised curriculum had improved subject content as the curriculum developers shifted subject content downwards the phases.

*Content for grade ten in the revised curriculum is now content for grade nine, that which used to be for grade nine has shifted to grade eight, and grade eight content has shifted to grade seven (NT1).*

For example, the respondents teaching physical science stated that some topics which were in grade 10 have been directly taken to grade 7 with the same content (NT1, NT4 & NT5).

*Some of the transferred physical science topics from grade 10 to grade 7 precisely without readjustments includes the topic of light, sound and waves. The change has made some teachers to have problems explaining the curriculum to the learners because they were trained on an old curriculum which had less advanced content. Therefore, these teachers are the most affected in coping with new topics that have been added to lower grades (NT4).*
According to (NT4), the professional development of teachers was supposed to have taken place before the implementation of the revised curriculum. The training could have equipped the affected teachers with the content knowledge to handle the revised and complex topics.

Additionally, (NT4) explained that some teachers who were trained to teach grade four as class teachers are now absorbed to teach the whole senior primary phase from grade four to seven. These are the teachers affected the most because we were trained in a particular phase and generally, most of the mathematics and science teachers are struggling with the revised curriculum. Additionally, senior primary subject content is complicated as compared to junior primary. Learners find it challenging to cope when they go to the senior primary, and this results in a high failure rate in grade 4 as compared to grade 3 (NT4).

These affect teachers were only trained to teach lower primary because grade four was part of the lower primary phase in the old curriculum. Therefore, proper coordinated implementation of the revised curriculum could have been a solution to some of these aspects in the revised curriculum. The variation between subject-contents of junior primary especially that of grade 3 the exit grade to grade 4 the entry grade into senior primary could equally have been solved in a good piloted revised curriculum.

Furthermore, argued which is worth to mention here is the variation that seems to be in-between what learners are learning in grade 1 to grade 3 compared to what they learn from grade 4 to grade 7. NT4 observed that the content of grade 3, which is the exit grade from junior primary, differs a lot from that of grade 4 the entry grade in the senior primary. To make matters worse, the medium of instruction changes in grade 4 from mother tongue to English and mode of teaching from one class teacher to different subject teachers. If the change of curriculum was well coordinated, a review was supposed to have taken place on grades 3 and grade 4 contents before the curriculum implementation. Therefore, the content from one phase (junior primary) is not well carried forward into senior primary phase. Amidst all this, schools are not getting enough resources on time, resources like textbooks.

6.1.3 Discussion about the Middle school science teachers’ views of science education (research question 1)

Both Finnish and Namibian science teachers’ argument about middle school science education focuses much on how learners must relate and understand the environment as they interact and
make a connection with it. They argued that it is essential for the learners to be able to communicate the scientific findings from practicals. Arguably, this falls a little short of what Alberts (2009) recommends that learners should be able to “know, use, and interpret scientific explanations of the natural world” (p. 437). From this understanding, the arguments fall short of necessarily making learners be able to use and interpret scientific explanations. It is from being able to know, use, and interpret scientific explanations that learners can generate and evaluate scientific evidence and explanations. Therefore, proactive participation in scientific practices and discourse gives a better understanding of the “nature and development of scientific knowledge” (Cobern et al., 2010, p. 82). The development of scientific knowledge must enable learners to comprehend the world, know what happens in nature and why it happens. This can lead to among others sustainable lifestyles and innovation.

Middle school science education in Finland is advanced due to the advanced teacher training and qualification as compared to Namibia. Finnish science teachers in junior secondary level are “subject specialists who have completed a Master’s degree in the subject they teach as well as pedagogical studies” (Ministry of Education & Culture, 2017; p. 25). Namibian science teachers in basic education, on the other hand, are required to have a “minimum of a diploma in education” (National Curriculum for Basic Education, 2016, p. 50). Based on the qualification requirements and training, the level of in-depth subject knowledge and pedagogical knowledge have an impact on the influence of teaching science education accordingly. The OECD (2010, p. 74) report attests to this by stating that “Finnish learners are more creative and can independently apply their acquired scientific knowledge and skills”. These skills can be applied to a wide variety of areas which includes unacquainted situations. The Finnish respondents equally confirmed this as they argued that science education is for lifelong learning and makes learners think outside the box; stimulates the development of inquiry and the inquisitive minds about the nature around us. Based on these arguments, Middle school science education seems to be well coordinated and provided to the learners by the education system and the teachers.

It is not easy to assess Namibian middle school science education on an international scale comparable to those of (OECD) Instruments of assessment like Programme for International Student Assessment (PISA). Nevertheless, based on the government of Namibia’s expenditure in basic education, the author can postulate that science education is on a steady rise in line with Namibia national vision 2030. It is the vision that is to see Namibia achieving a
“knowledge-based society and solve its development problems” (GRN, 2004, p. 10). Teamwork in the form of co-planning and co-teaching was one of the factors identified to be included in the pillars of science education success. Almost all Finnish middle school science teachers and above half of the Namibian middle school science teachers practice co-planning. See figure 6 below.

![Figure 6](image)

**Key: Black for Finland; Stripped for Namibia**

**Figure 6. Comparison of co-planning and co-teaching between Finland and Namibia**

Co-planning is the act when teachers of the same expertise come together and analyse the goals and objectives of the curriculum. Learners’ current academic needs are put into consideration as they focus on both “long-term goals and day-to-day teaching adjustments” to achieve the demands of the curriculum (Pratt, Imbody, Wolf & Patterson, 2017, p. 244). Finnish middle school science teachers seem to perfect this because teachers’ ability to teach and work collaboratively has been built steadily throughout the academic teacher training programme. On average, they spend at least “two hours of the collaborative planning of schoolwork per week” with colleagues of the same expertise (Sahlberg, 2013, p. 13). In Namibia, it is encouraged to do co-planning as well. However, the majority of middle school science teachers and other teachers usually find themselves as the only teacher of that specific subject. Co-teaching, on the other hand, is a service delivery model that introduces skilled teachers to a single classroom. It, therefore, cuts the teacher-learner ratio, maximises the attention and increases the amount of instruction each learner receives (Scruggs & Mastropieri, 2017). Because of this, it has academic and social benefits for both teachers and learners (Pratt et al., 2017). Learners benefit from refined instructions of more than one teacher. Teachers too benefit from each other as they serve as peer mentors to one another in refining their teaching methods (Pratt et al., 2017).
Both countries have had their national curricula revised recently (Finnish National Board of Education, 2016; The National Curriculum for Basic Education, 2016). The Finnish national co-curricular has been revised to strengthen the approach of which the phenomenon-based teaching approach has been introduced (Symeonidis and Schwarz, 2016). This approach sees learners working with several other teachers across subjects on “phenomenon-based projects” (p. 36). The Namibia national curriculum for basic education has been revised to align it with the country’s Vision 2030, which advocates for the attainment of a knowledge-based society (NCBE, 2016). It empowers learners to become active participants in the process of transforming Namibia into a knowledge-based society. Therefore, it requires learners to be involved in practical activities using their existing knowledge to create new knowledge.

The Finnish revised curriculum is envisaged with motivation for the learners to develop and acquire new knowledge from its phenomenon-based approach. However, some respondents feel that time allocation for practical work and full implementation of the new approach has been mismatched. Subjects like (geography and biology) have time allocation reduced, and more time has been allocated to subjects like art, physical exercises and home economics. Physics teachers feel relevant subject content has as well been reduced. In the overall assessment, the majority applauds the various assessment formats that have come with the revised curriculum. As Kloser, Borko, Martinez, Stecher & Luskin (2017) states, assessments are a great measure for informing teachers and learners about whether effective teaching and learning has taken place in science education. Effective assessment is critical to effective teaching and essential to effective science education (Kloser et al., 2017).

In the Namibian revised curriculum, the implementation seems to have taken place without teachers receiving the needed professional development training or much more not consulted. Some respondents especially those teaching Physical science complained that some teachers are struggling with the execution of the revised subject contents. The leading cause of the problem seems to be lack of adequate subject content knowledge for they were trained on an old curriculum with less advanced content. This has equally affected those teaching natural science at upper primary as some class-teaching-trained teachers for grade four have been absorbed to teach at senior primary. Therefore they have difficulties in handling new topics that have been added to lower grades as the phases have changed without effective professional training. Grade 4 is now part of the senior primary in the revised curriculum.
This situation confirms what Porter (2015) stated that “proper implementation of professional training for teachers is important especially when the curriculum undergoes significant changes” (p. 125). In the Namibian context, the curriculum revision has affected not only the content of subjects but likewise, the school phases; meaning the curriculum has undergone significant change. Argument from respondents can equally confirm the significance of the changes as the stated that the content of grade 3, which is the exit grade from junior primary, differs a lot from that of grade 4 the entry grade in the senior primary. Secondly, this has included subject content has caused teachers to have problems teaching science subjects especially natural science and physical science. Thirdly, some teachers who were trained to teach lower primary have been elevated to teach senior primary without undergoing extensive professional training. Fourthly, the change of phases that have seen grade 4 being changed to senior primary has resulted in learners failing to catch up with subject contents when they go to senior primary. Fifthly, this has resulted in high failure rates in grade 4 as compared to grade 3. Lastly, the respondents argued that the aspect of professional training was overlooked in the implementation of the revised curriculum. Therefore, a well-coordinated curriculum change, which could have included subject-content reviews, content review of the exit grade and the entry grade of each phase, and time allocation per subject before the implementation could have been one of the solutions.

### 6.2 Teaching methods in science education used in Finnish and Namibian Middle schools

The second research question of this study aimed to identify the science teaching methods used by Middle school teachers in Finland and Namibia. Table 8 and Table 9 below presents a broad view of the preferred teaching methods of Finnish and Namibian middle school science teachers. The main research findings are that: demonstration and lab work are the most preferred by the Finnish Middle school science teachers and class discussion and group work are the most preferred teaching methods by the Namibian Middle school science teachers.
6.2.1 The science teaching methods used by Finnish middle school science teachers

The results below in Table 9 shows the teaching methods preferred by the Finnish respondents and the number of times each method was cited.

**Table 9: Finnish middle school science teachers’ preferred teaching methods**

<table>
<thead>
<tr>
<th>Categories</th>
<th>Teaching Methods</th>
<th>Teachers (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FT1 Physics/Chemistry</td>
</tr>
<tr>
<td>Experiments</td>
<td>Lab work</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Practicals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Discovery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Demonstration</td>
<td>X</td>
</tr>
<tr>
<td>Small-group working</td>
<td>Group work</td>
<td></td>
</tr>
<tr>
<td>resource-based learning</td>
<td>Individual work</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reading/ writing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Class discussion</td>
<td>X</td>
</tr>
<tr>
<td>Creative-problem solving</td>
<td>Concept maps</td>
<td></td>
</tr>
<tr>
<td>Out of school, informal learning</td>
<td>Fieldwork</td>
<td></td>
</tr>
<tr>
<td>Teacher-led, large-groups lecturing</td>
<td>Lecturing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Storytelling</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Educational videos</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Question &amp; Answer</td>
<td></td>
</tr>
</tbody>
</table>

Note: T stands for Teacher
FT= Finish teacher

Most respondents prefer using demonstration as the teaching method except (FT5). Demonstration teaching is followed by Lab work, where only (FT2 & FT7) did not mention lab work. With the supervision of the teacher, learners carry out scientific-practical work in small groups. Half of the respondents use reading/writing. This includes teachers writing down notes on the black/whiteboards as learners copy and study and giving them essays to write or summaries to read. FT2, FT4 and FT8 use class discussion; (FT3, FT7 & FT8) indicated to be using lecturing teaching method; and (FT1, FT5 & FT6) prefer using educational videos. In class discussion, the teacher initiates the discussion about scientific concepts and general learning tasks. The teacher can equally divide learners into small groups to discuss further the given scientific concepts before reporting to the rest of the class. In lecturing, the teacher
directly presents scientific concepts to the learners as they sit back and listen as the teacher explains giving details of the concepts. In using educational videos, learners equally sit back and watch educational videos about scientific concepts as the teacher moderates the show. Only (FT6 & FT7) indicated the use of question and answer, while individual work and storytelling were mentioned by (FT2), fieldwork by (FT5), group work by (FT3) and discovery by (FT7).

During question and answer session, the teacher mainly moderates the dialogue by posing questions to the learners as they too respond or ask questions as well. The teacher then allows other learners to respond and only gives clarity if the responses from other learners are not satisfactory. Therefore, learners can debate scientific concepts and theories. Storytelling is linked lecturing as the teacher incorporates real-life phenomena in explaining scientific concepts and theories. Individual work is mainly allowing learners to use textbooks and other sources like the internet to study or get the needed information about a given task or solve problems individually. Fieldwork takes a form of visiting educational sites like museums, exhibitions, science centres and/or the surrounding ecosystems. Group work allows learners in small workable groups to formulate concept-maps that clarify relations of concepts before clarification from the teacher. Finally, discovery teaching is allowing learners to discover scientific facts as they initiate and perform practical work independently. They can develop ideas or conceptions by brainstorming, and then use scientific theories to prove these developed conceptions.
6.2.2 The science teaching methods used by Namibian middle school science teachers

The results below in Table 10 shows the teaching methods preferred by the Namibian respondents and the number of times each method was cited.

**Table 10: Namibian middle school science teachers’ preferred teaching methods**

<table>
<thead>
<tr>
<th>Categories/Themes</th>
<th>Teaching Methods</th>
<th>Teachers (T)</th>
<th>Rural teacher</th>
<th>Urban Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NT1 Physical Science</td>
<td>NT2 Life Science/ Geography</td>
<td>NT3 Physical Science</td>
</tr>
<tr>
<td>Experimental</td>
<td>Class practicals</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Demonstration</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Discovery</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Small group working</td>
<td>Debate</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Group work</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Pair work</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Role-plays</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Resource-based learning</td>
<td>Individual work</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Reading/writing</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Creative-problem solving</td>
<td>Class discussion</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Out of school, informal learning</td>
<td>Brainstorming</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Teacher-led, large-groups lecturing</td>
<td>Lecturing</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Question &amp; Answer</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Note: T stands for Teacher
NT = Namibian Teacher

Most respondents prefer using class-discussion and group work as the teaching method. Only (NT1, NT2 & NT8) did not indicate to prefer class-discussion and (NT3, NT4 & NT8 did not indicate to prefer group-discussion as a teaching method. Class discussion and group work are the most preferred teaching methods because they are more learner-centred in approach and easy for use. Teachers still return much of the control as they always select specific topics for discussion; they choose topics which learners are to do in small sizeable groups. As stated by (NT5) that:
We group learners in sizeable groups and give them questions to discuss in their small groups (group-discussion), and they come present to the rest of the class, and we discuss altogether with the rest of the class (class-discussion).

In most cases, learners have to report their group works to the rest of the class for further class discussion. Pair work follows group work and class discussion with half of the respondents citing it. In pair works, it is the same strategy used in group-work, only that the group is limited to two learners. Demonstration, class practicals/lab works, individual work, and lecturing are all weighted the same with almost half of the respondents citing them. Demonstration and practical or lab works are mostly close together. Due to limited resources, teachers mostly demonstrate as learners observe. About a quarter of the respondents cited debate and role-play (NT3 & NT4) and (NT4 & NT5) respectively. In debate, the teacher allows learners to debate scientific theories and concepts while in role-play, the teacher directs learners to role-play some scientific theories. Discovery, brainstorming, and, question and answer all are having been cited by only one responded (NT1). Brainstorming allows learners to ideate in small sizeable numbers pertaining a problem-solving activity.

**Namibian middle school urban-rural teachers’ preferences of the teaching methods**

A notable difference was visible in these teaching methods: debate, reading-and-writing, and, lecturing. See Figure 7 below for a more detailed presentation of the comparison of teaching methods of Middle school science teachers in rural and urban schools in Namibia.

![Figure 7. Comparison of teaching methods of rural vs urban middle school science teachers in Namibia](image)

*Key: Black colour for rural schools; Striped for urban school*
There were no rural Middle school science teachers who cited lecturing as opposed to the urban Middle school science teachers. None of the rural Middle school science teachers cited reading-and-writing as opposed to urban Middle school science teachers. Additionally, no urban Middle school science teachers cited debate as opposed to the rural Middle school science teachers. Pair work and class discussion teaching methods had the same preference among rural and urban teachers which was almost a quarter of the respondents each.

6.2.3 Similarities and differences in the preferred teaching methods of Finland and Namibia

Majority of Finnish middle school science teachers prefer lab-work/class practicals as only (FT2 & FT7) did not cite lab-work/class practicals as a teaching method compared to half of the Namibian respondents. The Finnish science teachers argued that *lab-work maximises knowledge retention; improves scientific skills and enriches understanding*. According to the collected data, Namibian middle school science teachers prefer using group-work and class discussion more preferably as compared to Finnish respondents. See Figure 8 below which details the varying comparisons on the teaching methods that are common in both countries.

![Figure 8. Common teaching methods in both countries](image)

Key: Black: Finnish respondents; Striped: Namibian respondents

According to the collected data, only (FT3) indicated to prefer using group-work in Finnish sample as compared to about over half from the Namibian sample. It is similarly the same with class discussion teaching method as about over half of the Namibian respondents stated to prefer class discussion compared to less than half from the Finnish sample. The Namibian Middle school science teachers argue that: *group work and class discussion teaching methods*
maximise learners’ participation; enriches their understanding and suitable for interaction. Almost all the Finnish middle school science teachers prefer to use demonstration as a teaching method except (FT7). On the other hand, less than half (NT1, NT4 & NT6) of the Namibian Middle school science teachers indicated to prefer using demonstration. Moreover, one teacher from each sample stated the use of discovery as a teaching method (FT7 & NT1).

The teaching methods only mentioned in either country

Almost half of the Finnish respondents use educational videos as a teaching method. About a quarter of the Finnish respondents indicated to prefer using storytelling as a teaching method, and only one (FT5) uses fieldwork; and, (FT6) uses concept maps as teaching methods respectively. Figure 9 below details the teaching methods that have only been mentioned in each country as one of the teaching methods of Middle school science teachers.

Figure 9. Teaching methods only mentioned in either country

In the Namibian sample, none of these teaching methods was mentioned. About half of the respondents use pair work as a teaching method and (NT4 & NT5) prefer the using role-play, and debate as a teaching method is only preferred by (NT3 & NT4). These were also not mentioned in the in the Finnish sample.

6.2.4 Discussion of teaching methods in Middle school science education in Finland and Namibia (research question 2)

Majority of the mentioned teaching methods in the Finnish sample falls in the category of experimental teaching methods with almost all the respondents indicating to be using both demonstrations and lab work and/or class practicals. Teacher-led and/or large-groups lecturing
methods follows with a combined preference which is above half of the respondents. These categories of teaching methods (experimental and teacher-led and/or large-groups or lecturing) gives the teacher much control and guidance of the teaching and learning process and “dominates the communication transmission” (Juuti et al., 2010; p. 615). This was confirmed by respondents when stating that it is essential to supervise learners when doing lab-work as they might not follow the given instructions and end up doing something else. Similarly, some argued that even after giving specific instructions, it is still important to monitor how learners are doing and if they are following the given instructions. The mentioned teaching methods that give much autonomy to the learners in the Finnish sample fall into the categories of resource-based learning, which almost all the teachers are using it. Small-group-working, creative problem solving and out of school informal learning are the least preferred teaching methods.

An argument can be put forth that these preferred teaching methods have been useful in producing the desired middle school science results in Finland. This can be supported with the fact that Finland has been among the best performers in scientific literacy, science proficiency science performance and scientific literature from about 2000 up to the current PISA reports of 2016 (Bybee et al., 2009; OECD, 2010; OECD, 2014; OECD, 2016). However, the results further reveal that what (Juuti et al., 2010) had found that there is a need for Finnish Middle science teachers to diversify and include a variety of science teaching methods. Teaching methods which can be able to involve more learner interaction and participation like small group-discussion that includes (debates, group work and/or pair work, and, role-plays). Creative problem solving which includes: Problem solving, brainstorming, and overall/concept mapping of a problem situation). Remarkably, these teaching methods have a very low preference in the Finnish sample.

Majority of the mentioned teaching methods in the Namibian sample falls in the category of small-group working teaching methods with a combined preference of thirteen. Resource-based learning follows with a combined preference of 10. These categories of teaching methods (small-group working and resource-based learning) give much control and management of the learning process to the learners as they “dominate the communication transmission” (Juuti et al., 2010; p. 615). Some respondents argued that these methods improve communication skills, makes learners friendly and encourages teamwork. As argued by respondents, these teaching
methods enable slow learners to learn from fast learners as sometimes they fail to understand what teachers teach but can easily understand other learners better.

The other teaching method that gives much autonomy to learners is creative problem solving which it preference was below average. The remaining mentioned teaching methods fall into the category of experimental teaching methods of which almost half of the respondents preferred class practical. This was also the same with demonstration teaching method, it was preferred by almost half of all the responded with discovery teaching method being preferred by less than half of the respondents. Half of the respondents indicated the preference and use of the teacher-led and/or large-groups lecturing methods. This category of teaching methods gives the teacher much control and guidance of the teaching and learning process. It is the teacher who further dominates the communication transmission Juuti et al. (2010) Namibian middle school science teachers seem to be on course with what Juuti et al. (2010) stated about the use of discussion as a teaching method. They argued that discussion is the primary motivator for learners to study science subjects (Juuti et al., 2010, p.619) and discussion seems to be more prevalent in the Namibian results. Discussion is the main mode of delivery in group work and/or pair work, class discussion and brainstorming. Moreover, it increases the level of interaction among learners.

6.3 Reasons behind the preferences of the teaching methods (research question 3)

The third research question of this research aimed to identify the reasons behind the preferences of the teaching methods for Finland and Namibia. These reasons follow as a justification for the listed methods used in these two countries.

6.3.1 Finnish middle school science teachers’ reasons behind the preferences of the teaching methods

Finnish respondents argued that it is essential to collect data from the lab-works, as learners can easily understand if they see what happens during experiments. Respondent FT1) gave an example of the exothermic reaction that can be observed when reacting a base with an acid:

Learners are capable of feeling the heating effect as the reaction takes the course by touching the test-tube. FT1 further stated that this helps learners to develop a vision of what happened during the practice as they write it down, and thus maximises their knowledge retention.
Moreover, respondent (FT3) stated that doing lab-works allows learners to examine the phenomenon. According to (FT3), lab-work is usually preceded by a demonstration then after learners can carry on with their inquiry-based learning with guidance.

FT3 stated that it is important to discuss their observations, give remarks and comments by connecting the practical work to theory and after that write down some notes. Additionally, (FT1) argued that sometimes it is essential to incorporate practical work with some short-scientific YouTube videos.

*Educational videos can significantly help learners to have a deeper understanding of the phenomenon under investigation (FT1).*

In the opinions of (FT2 & FT5) using different methods at once is more useful as different topics require different teaching techniques. While (FT6) argued that a variety of teaching methods could help learners to recognise which methods make them learn best because every learner has a different learning style:

*Sometimes, a teacher must use lecture method; sometimes allow learners to write notes, research different topics, and sometimes we do concept maps with computers. Learners can do some practical-works, examining structures, watching videos, mini workstations where learner showcase and demonstrate (FT6).*

The application of using different teaching methods could enable learners to have many ways of exploring phenomenon; allow them to relate to everyday life and thus, maximises their understanding. The constructivism teaching approaches support the argument especially the phenomenon-based teaching (Silander, 2015a) and inquiry-based learning which replicates real-life situations for learners (Harlen, 2013). It provides opportunities for learners to apply their knowledge and skills during activities thus enrich understanding and improves their scientific skills (Habók, 2016). In return, it makes learners develop a definite interest in science. Remarkably, respondents (FT3 & FT4 argued that good results obtained by learners are evidence that the teaching methods they use are working. Nevertheless, respondents emphasised more on the importance of scientific investigations as vital in developing the learners’ scientific skills. Scientific skills which include observation skills, scientific processing skills: communicating skills, classifying, measuring, inferring, and predicting.
6.3.2 Namibian middle school science teachers’ reasons behind the preferences of the teaching methods

Namibian respondents argued that class discussion, group work and/or pair work produce the best learning outcomes. Except (NT8) all respondents stated that learners could discuss scientific concepts in groups and/or pairs before class discussion of a new topic could follow. Learners can then come and present their findings to the whole class. Therefore, class discussion, group work and/or pair work enables learners to share information. NT3 stated that some learners might not be able to participate in a teacher-led, large-group lecture or dialogue, but can participate in smaller sized groups thus maximising their knowledge as they learn from each other. Additionally, NT2 stated that:

*These teaching methods prepare learners for examinations and affect their performance as it manifests in their performances during the end of term examinations and eventually increases their interest in science subjects (NT2).*

Apart from the possibility of increasing the interests of learners in science subjects, group and/or pair work develops the communication skills of the learners. Communication skills can prepare learners for future endeavours in their professional lives. This was in the opinion of (NT4), stated that:

*Class discussion makes learners interact as they learn from one another by sharing ideas. They learn best when they share knowledge with peers (NT4).*

This argument is supported by (Tracey & Morrow, 2012) who argue that “social learning develops knowledge” (p. 116), and the active construction of knowledge by individuals (Gunning, 2010). Moreover, it is useful in making learners not to forget what they learnt from others and enables them to make inferences and to draw conclusions of their work. On the other hand, (NT2) stated that:

*Learners’ individual-work makes them work extra hard and prepares them well for the national assessments (national examinations) as compared to other teaching methods (NT2).*
Group work and/or pair work, for instance, can sometimes make the most capable learners dominate and produce everything as the others follow the dictates of the outspoken and eventually benefit from the group grading. Some respondents argued that class experiments/lab works makes learners to experiment and prove facts of the theories they have learnt by putting them into practice. It gives learners a broader understanding of the phenomenon. It is similar to the use of demonstrations, where the teacher uses models to explain and demonstrate how the phenomenon works which can provide a broader understanding of the curriculum. Moreover, (NT1 & NT4) stated that carrying out experiments enables learners to acquire and enhance the needed scientific skills as outlined in the syllabuses.

*Learners can develop an interest in science subjects when carrying out experiments and when they develop scientific models for demonstrations (NT4).*

This can lead to learners designing their own experiments and developing models to explore some scientific phenomenon (learner-centred open inquiry) (Kang & Keinonen, 2018). Additionally, this as well has the potential to improve the performance of learners and steadily maximises their knowledge retention. Therefore, Practicals can make an impact on learners’ scientific skill development because they practice with hands-on.

### 6.4 The assessment of the implementation of Middle school science teaching methods

The fourth research question of this study aimed to identify how middle school science teachers in both countries implement their teaching methods. Some of the main findings include collaboration with other teachers, giving more practical work, incorporating learners’ views in planning and imparting scientific knowledge to learners to be among the essential things science teachers should do.

Some issues that affect the smooth implementation of middle school science education include different abilities of learners in mainstream classes. A learner who seem to be quite older on average as compared to the others also seems to have less motivation in learning. Inadequate of the provision of science teaching aids in Namibian Middle schools. Lack of enough time for doing practical works, big sized classes and mismatched curriculum contents to the allocated time.
6.4.1 Finnish middle school science teachers’ assessment of the implementation of science teaching methods

The following are the views of Finnish respondents concerning the implementation of their teaching methods and science education. Almost all argued that collaboration with other teachers helps in refining their teaching methods and in executing them. FT8 added that listening to the views of the learners must be considered in planning. Moreover, (FT1) stated that it is always important to start teaching with the presentation of the main themes of the lesson when teaching.

*Science teachers need to create learning environments where learners have much to do; more of practical-tests and active investigation as opposed to science lecturing. When learners are doing class-exercises go and help those with individualised problems and, science classes must be more spacious (FT1).*

FT7 suggested that science teachers should teach science from grade 1 as a way of providing learners with necessary scientific skills at an early stage.

*It is supposed to be science teachers to introduce scientific education earlier as opposed to class teachers for lower grades (FT7).*

From this argument, it can be suggested that science teachers are better positioned to see the progress of learners from an early age to the end of the comprehensive school.

**The issues that affect the implementation of the teaching methods negatively**

Some of the highlighted challenges affect teaching and learning include the differences in the learners’ learning abilities and reading skills; and, their motivational levels. According to (FT5), the leading cause of this is the school system which allows every learner from the area near the school to come to the same school.

*They do not take any exams or any qualifications to come to school as long as they live in that area (FT5).*
The comprehensive school system seems to be silent on issues about how better to accommodate learners with varying abilities as (FT1) complained that:

*We have learners in the same grade who barely can read, some to such an extent that they do not even understand the sentences. Consequently, the teacher is then forced to explain to the learners what it means and expected of them (FT1).*

According to (FT1), it becomes challenging to balance on how to cater for all the learners’ needs and equally keep their concentration in a lesson because of these differences. FT2 complained about over-aged learners in middle school to be one of the pressing issues.

*The more they are ageing, the harder it becomes for them to concentrate on schoolwork (FT2).*

Among the Finnish respondents, (FT6) stated that they do not have enough time to do practical work and more phenomenon-based teaching.

*The curriculum has a lot of stuff to teach but time is not enough. It requires different evaluation methods (FT6).*

FT3 observed that the main problem is a lot of happenings in the school. In (FT3)’s opinion, many school holidays disturbs teaching and learning.

*These many holidays, makes us develop the feeling of hurriedness as we are put puts under strain to finish the curriculum (FT3).*

The revised curriculum seems to have reduced time allocation for biology and geography.

*The revised curriculum has about one hour per week in Biology and Geography (FT2).*

Furthermore, the time factor is similarly a matter of concern in Finnish middle school science education. Half of the respondents complained about not having enough provision of time for doing practical works and allow learners to have personal time to explore phenomena that could develop their independent inquiry in science.
6.4.2 Namibian middle school science teachers’ assessment of the implementation of science teaching methods

The following are the views of Namibian respondents concerning the implementation of their teaching methods and science education. Majority of the respondents stated that science education is good but comes with some challenges in execution. NT1 stated that:

*Imparting scientific knowledge to learners is an essential thing for we educate them to know the relationship with their environment. Each teaching method is fundamental and beneficial to both the teachers and the learners. More important to the learners because these are the people required to take up scientific careers in the future, which includes teachers, nurses, doctors and engineers. All these fields are based on science education, and any science field has an experimental part (NT1).*

Therefore, the need for carrying out experiments and demonstrations is essential for developing scientific inquiry minds. Additionally, (NT4) stated that the use of a variety of teaching methods helps to cater for all the learners as they have different learning styles. (NT6) argued that using different teaching methods can lead learners to acquire scientific skills easily. These skills include observation, prediction, measuring, and communication and eventually produce learners who are to progress to the next phase with the necessary scientific skills. NT2 highlighted that science subjects have some sensitive topics like diseases, which includes sexually transmitted diseases (STD), and the human immunodeficiency virus (HIV).

*Some learners are (HIV) positive and taking Antiretroviral (ARV) drugs. It becomes difficult to teach these topics because of the stigma attached to these illnesses. Therefore these topics should be introduced much earlier from the senior primary (grade 5) as opposed to grade 8 and grade 10 as per the curriculum (NT2).*

In the opinion of (NT2), introducing these topics early in the senior primary phase can make learners develop with the understanding and acceptance of those on treatment and those affected.
The issues that affect the implementation of the teaching methods negatively

According to the respondents, lack of enough resources hinders the progress of teaching science education in middle schools especially those teaching Physical science and Life science. In exception of (NT7), all the respondents argued that they have no teaching aids for science and are very scarce to purchase. (NT4) stated that there are only a few companies that sale apparatus and chemicals for school science in Namibia and therefore they have monopolised the market and became quite expensive. NT1 argued that it is not easy to perform class experiments and other practical work with limited resources when you have quite a significant number of learners.

*If you have a class size of 30 learners, it requires many litmus paper pieces to demonstrate the effect of acids and bases. Therefore, in two classes, you end up using 60 pieces of litmus papers just for one demonstration. Our current resources cannot sustain this. Therefore, it is easy for the teacher to demonstrate as learners observe or have them perform in groups (NT1).*

Respondents complained that lack of textbooks for learners is another daunting problem as much of the available textbooks are no longer in line with the revised curriculum. According to (NT7):

*In grade 9 Geography, there are 3 classes with about 32 learners in each, sharing about 10 textbooks. As a result, learners are only allowed to use these books during lessons. They cannot borrow them for their personal study and research resulting in learners being negatively affected when given homework (NT7).*

Remarkably, (NT4) observed that some science teachers lack the expertise to use some of the acquired science equipment.

*Some fail even to obtain carbon dioxide and oxygen. Therefore, it is hard as there are topics that need an experiment or a practical demonstration. This has resulted in some teachers failing to apply different strategies in teaching and which makes them be lecturing even where the practical demonstration is needed (NT4).*

Urban teachers observed that learners especially those from inner cities (informal settlements) were indiscipline. NT7 stated that:
Some behaviour problems suggest having poor or difficult upbringing of these children from informal settlements (inner cities). Schools do not have an easily accessible psychologist to help learners who may need psychological help. Teachers try to help them but are limited regarding psychological expertise these learners need (NT7).

Another pressing issue the majority of the respondents complained about was ‘time’, especially for Physical science syllabus. Some teachers stated that Physical science syllabus has many competencies that need to be to be covered and the average time allocated to teaching is not enough to cover them all.

The curriculum developers did not consider the issue of teaching-time when correlating subjects’ contents and time allocation. Due to the limited time, we are forced to be using weekends (Saturdays and Sundays) and holidays for teaching in order to complete the syllabus before examination time (NT5).

Additionally, (NT5) further stated that the demand for covering the syllabus had left them with little time to attend to their private lives during holidays. The medium of instruction which is English was also mentioned as one of the barriers affecting the progress of learners in middle school science education. Majority of the respondents stated that they still learners in the junior secondary phase who still have difficulties in using English fluently.

6.4.3 Discussion of the implementation of middle school science teaching methods (research question 4)

Almost half of the Finnish respondents complained about lack of time compared to almost all the Namibian respondents who teach physical science and Life science complained about lack of enough time for teaching. The researcher can recommend that the complaints from the Finnish respondents seem not to be monumental in the implementation of the curriculum. All that can be done is to device good planning. Having proper time management and put all these issues raised under control. The interesting time allocation that can amount to a barrier in the implementation of the curriculum is with the Namibian respondents. According to respondents’ responses, only (NT2, NT3, & NT7) who did not complain about mismatched time allocation with the subject content. NT2 teaches Life science; NT3 and NT7 are teaching Geography. Those who are teaching Physical science (Chemistry and Physics) including one for Life
science stated that time allocated for teaching is not adequate. Based on these complaints, it seems that the curriculum planners/developers did not consider time-factor in the revised curriculum development for Physical science. NT5 even stated that the revised curriculum content forces them to sacrifice weekends and holidays to teaching. This according to (NT5) is the only way they can be able to cover up the whole syllabus requirement before learners sit for their yearly examinations. It is similarly argued by (Awe & Kasanda, 2016) that “the time allocated for teaching Physical Science needs to be increased” (p. 43). All the promotional subjects have equal time allocation (see Table 11 below).

Table 11. Time allocation per subject for a 7-day cycle (40 minutes) per period in Namibia

<table>
<thead>
<tr>
<th>KEY LEARNING AREA</th>
<th>SUBJECT</th>
<th>% TIME</th>
<th>7-DAY CYCLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LANGUAGES</td>
<td>English (first or second language)</td>
<td>10,7%</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Another language (first, second or foreign) Reading period</td>
<td>10,7%</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Mathematics</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>MATHEMATICS</td>
<td>Mathematics</td>
<td>12.5%</td>
<td>7</td>
</tr>
<tr>
<td>NATURAL SCIENCES</td>
<td>Life Science</td>
<td>9%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Physical Science</td>
<td>9%</td>
<td>5</td>
</tr>
<tr>
<td>SOCIAL SCIENCES</td>
<td>Geography</td>
<td>9%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>History</td>
<td>9%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Life Skills</td>
<td>3%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Religious and Moral Education</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>TECHNOLOGY</td>
<td>Pre-vocational</td>
<td>9%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Information and Communication</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>SUPPLEMENTARY SUBJECT</td>
<td>Pre-vocational or another language (first, second or foreign)</td>
<td>9%</td>
<td>5</td>
</tr>
<tr>
<td>ARTS</td>
<td>Arts</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>PHYSICAL EDUCATION</td>
<td>Physical Education</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100%</td>
<td>56 periods per cycle</td>
<td></td>
</tr>
<tr>
<td>TOTAL TIME PER CYCLE</td>
<td>37 hours 20 min</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adapted from, (MoE, 2016).

Curriculum developers were supposed to have considered the contents of each subject and the allocation of the possible amount of time that correlates with the demands of each subject (Millar, 2011). This mismatched time for science curriculum can counter the envisaged transformation of the country into a knowledge-based society by the year 2030 (GRN, 2004). It equally adds to other challenges that include poorly resourced schools with no hands-on materials for teaching sciences (UNICEF, 2011). Remarkably, not all the three Namibian schools where data was collected from are having a functional laboratory. Additionally, some teachers lack subject-content knowledge as observed by (NT4). Nakashole et al. (2017) and Ottevanger et al. (2007) confirms this that some teachers still do not have the sound subject-content knowledge to explain the curriculum generally and especially in science subjects. Lastly, collaboration with other teachers comes out as a strength in the Finnish middle school science education in refining their teaching methods and approaches. Almost all the Finnish
Middle school science teachers indicated collaborating in planning and teaching see Figure 6. Sahlberg (2013) similarly, argued that Finnish science teachers spend at least two hours of their schoolwork per week for collaborative planning.
7. Conclusions of the study

This study sought to identify the preferred teaching methods used by middle school science teachers in Finland and Namibia. Many curricula have science education as the central pillar of their education systems (Millar, 2011), so, it is worth to investigate the methods used by the implementers of the school curricula. Aldajah (2014) likewise argued that teachers as designers of teaching methods and learning experiences should be mindful of the diversity of learners’ learning styles and abilities. They should be able to design pedagogical experiences that appeal to different kinds of learners and help them to get the most out of their learning experiences (Aldajah, 2014). Teachers must always ensure that the teaching methods used are more relevant to the learners and best in achieving the desired teaching goals. The instruction must focus on cognitive development, which includes intuition, sensing, imagination as well as analysis, reason and problem-solving (Nilson, 2016; Schunk, 2012). To this end, a case-based cross-national comparative approach was used where Finland was a case and Namibia another case (Vaus, 2008).

Based on the observations the following stands out as the main findings of the study. Finnish science teachers tend to apply the use of experimental teaching methods more while Namibian science teachers tend to apply the use of small group working methods more. Because the experimentation methods require laboratory equipment, the differences in approach in the Namibian context are due to limited resources. In Finland on the other hand, the popularity of the experimental teaching methods can be explained mainly in reference to the availability of science teaching resources. In the Namibian context, the reliance primarily on the small working methods deprives learners of the opportunity to acquire some scientific skills that come with experimental activities. In light of these implications, science teaching in Namibia requires the government to invest more resources in middles school. This would allow teachers to use a variety of teaching methods. Finnish Middle school science teachers, on the other hand, must include teaching methods that involve more learner interaction and participation like small group working.

7.1 Effects of the study to Middle school science teachers and science education

The findings unearthed many similarities as compared to differences. In both countries, Middle school science education focusses on how the learners must relate and understand the
environment and be able to draw conclusions and communicate scientific findings. This, however, falls short of the whole aims of science education which includes knowing, use and interpret scientific explanations of the natural world. It is from these that learners can generate and evaluate scientific evidence and explanations. Co-planning and co-teaching of science is an essential way of sharing expertise, and their application has a lot of academic and social benefits to both teachers and learners in general (Pratt et al., 2017). Co-teaching a number of difficult scientific concepts leads to the improved attention of learners as it increases the amount of instruction each learner receives (Scruggs & Mastropieri, 2017).

In the national curricula, it is evident that more time allocation is needed for practical work especially for the Namibian middle school teachers whom almost all of the respondents complained about it. Science subjects need to be allocated the appropriate time because of the nature of the study. It requires reasonable time for conducting experiments and exploring scientific concepts. From these statements, it could have been necessary if the ministry of education could have piloted revised curriculum for proper implementation. It is also vital to note that the revised curriculum has affected the teachers negatively that some are failing to cope with the newly improved subject content. If successful piloting of the revised curriculum could have been dealt with accordingly, the ministry of education could have offered the needed professional development to the science teachers before the full implementation. Research has it that the most important goals of science education are preparing effective science teachers, which includes helping in-service science teachers improve their orientations toward science teaching (Sahingoz, 2017).

Figure 8 and Figure 9 displays teaching methods common in both countries and teaching methods only mentioned in either country. Finnish middle school science teachers prefer lab-work/class practicals more as compared to the Namibian middle school science teachers. This study further revealed that experimental teaching methods and teacher-led and/or large-groups lecturing methods are more inclined to teacher-centred teaching methods. This is because experimental teaching methods give much autonomy to the teacher as opposed to the learners. These methods give the teacher much control and guidance of the process and dominate communication transmission (Juuti et al., 2010, p.615). Namibian middle school science teachers prefer using group-work and class discussion more as compared to Finnish middle school science teachers. These teaching methods belong to the category of small group teaching methods and resource-based learning teaching methods. They provide much control and
guidance of the process to the learners as they dominate the communication transmission (Juuti et al., 2010). Because autonomy is given to learners, these methods are more inclined to learner-centred teaching methods. Middle school science teachers need to diversify the base of their teaching methods include both, methods, which are learner-centred driven, and those, which are teacher-centred driven (Westwood, 2008).

Various reasons have been cited as the influence of the preferences in both countries. Among the reasons, these are worth mentioning: Experimental teaching methods allow learners to examine the phenomenon with hands-on activities. This improves the inquiry-based skills of the learners, which allows them to relate what they learn and discover, to everyday life situations. The application of different teaching methods enables learners to have many ways of exploring the phenomena and maximises their understanding. This argument is backed by research as it is derived from a constructivism teaching approaches especially the phenomenon-based teaching (Silander, 2015a p.19) and inquiry-based learning which replicates real-life situations for learners (Harlen, 2013). Apart from being more based on constructivism theories, experimental teaching methods have the potential of instilling inquiry skills in learners as early as middle school level.

7.2 The significance of the study to policy makers

This study investigated the preferred teaching methods for science teachers. The findings of the study reveal that effective teaching is not necessarily bound by the specific teaching approach of either learner-centred or teacher centred (Westwood, 2008). At the middle school level, learners need explicit guidance in learning. Thus, teaching methods that are teacher-centred are more applicable and relevant. Regardless of this, Middle school science teachers in Finland must nonetheless include more teaching methods that give more autonomy to the learners. For the results confirms what (Juuti et al., 2010) recommended that there is a need for Finnish Middle school science teachers to have a range of teaching methods which can maximise interaction among the learners. Teaching methods like small group-discussion that includes (debates, group work and/or pair work, and, role-plays). Additionally, creative problem solving which includes: problem-solving, brainstorming, and overall/concept mapping of a problem situation).
The study also reveals that due to a lack of resources, Namibian middle school science teachers could not implement experimental teaching methods properly. This is causing the majority of teachers to be restricted to performing demonstrations only as learners observe. The ministry of education can address this by providing more science educational resources in Namibian Middle schools. This will enable the science teachers to include teaching methods that are more experimental based which can improve the inquiry-based learning skills of the learners (Awe & Kasanda, 2016). Experimental teaching methods have the potential of seeing learners carrying out investigations in the learner-centred open inquiry (Kang & Keinonen, 2018). With the rapid advancement in science and technology, experimental teaching methods can significantly influence learners in ways of experiencing and interacting with scientific phenomena and the world around them (Tan & Kim, 2012). This can translate into the practice of science education that is proactive and relevant to the learners. The ministry of education further needs to re-evaluate the time allocation to science subjects. This is because the respondents who teach physical science feel that time allocation has been mismatched with the subject contents to be covered. Another issue for consideration is the introduction of topics of sexually transmitted diseases (STD), and the human immunodeficiency virus (HIV) as early as in the senior primary phase. This study revealed that teachers find it hard to introduce these topics especially HIV and AIDS in middle school when learners are more sensitive because of the stigma surrounding these illnesses. Therefore, introducing them as early as senior primary can enable learners to grow and develop with the acceptance of one another regardless of their status.

The ministry of Education further needs to review the current system of teacher professional development, which follows the cascade model to ensure that the existing professional development needs of teachers, could be met in a timely manner. Meeting the professional development of teachers is very significant especially when the curriculum undergoes major revisions (UNICEF, 2011). This study revealed that some middle school science teachers need professional development in enhancing their subject-content knowledge. It was remarkable to learn that some teachers do not have the skills to obtain simple gases like carbon dioxide and oxygen. Cascade model is a professional development system where a group of trained teachers go and train other teachers in schools (Bett, 2016). In the Namibian education system, the responsibility for providing professional development to teachers is with the senior education officers. These can be those at the National Institute for Educational Development (NIED) or those stationed at the regional level in regions.
7.3 Recommendation for future research

The focus of this research was on science education and the preferred teaching method for junior secondary schools. Based on the findings of this study, many areas of science education warrant further research of which: inclusion of an observation protocol to the data collection instruments could have produced results that are more detailed. The observation protocol could have exposed the researcher to actual everyday teaching, which could have given the researcher first-hand application of science teaching methods. The application of mixed methods approach could have equally supplemented positively on the qualitative data gathered through the interview protocol. A quantitative research instrument like a Likert scale could have covered specific issues as compared to what was mentioned during the interview. The collection of data from a more extensive site both in Finland and in Namibia could yield results that are more balanced.

The study has shown that the revision of the curriculum by the planners/developers did not consider the time-factor specifically in matching physical science content and time allocation. The author recommends that further research must be taken by the Ministry of Education to ascertain themselves about this matter further. Generally, science subjects seem to demand more time in comparison to other school subjects due to nature and experimental aspects the teaching and learning of science requires.

This study has further shown that the adoption of learner-centred teaching approach did not go well in a number of countries, which includes Namibia and Finland (Awe & Kasanda, 2016; Juuti et al., 2010). Other countries which have been cited here include South Africa, Tanzania and Turkey (Spreen & Vally, 2010; Mafumiko, 2018; Gurses et al., 2015). Therefore, more research, especially in light of what (Clark et al., 2012; Sweller, 2009; Kirschner et al., 2006) argued need to be explored. A number of researchers have argued on the shortcomings of the teaching methods emanating from learner-centred teaching approach (Tilya & Mafumiko, 2018; Spreen & Vally, 2010; Gurses et al., 2015). However, not much research has been conducted done on how to improve teacher-centred teaching methods. Remarkably, it seems many teachers continue to apply teacher-centred teaching methods in practice (Awe & Kasanda, 2016; Gurses et al., 2015). Therefore, research and attention need to be paid on the methods emanating from teacher-centred teaching approach. It is for the policymakers,
professional development providers, college professors, and teachers, in general, to look into these implications.

7.4 Limitation of the study

Since the aim of the study was to compare the teaching methods of the Finnish and Namibian science teachers, it has some limitation in the data collection instruments. The observation instrument in both countries could have supported the interview protocol used in this research. This could have informed the study more in detail because it could have had the advantage of comparing the interview data with actual teaching experience. Participation of learners in the findings of the preferred teaching methods could have given a good base of comparison and concluding. These results could have been supplemented by data captured from learners using an instrument similar to what Juuti et al. (2010) used. This could give a more comprehensive interpretation of the results.

Mixed methods approach could have produced more comprehensive results as compared to qualitative research approach. The minimum required sample size for applying mixed methods could have required more time for data analysis, which unfortunately could not have been favourable for the limited time the researcher had. The language barrier was another limiting factor. Some Finnish science teachers were not well conversant in English and that limited them in expressing their views and responding in a more detailed way. In the Finnish sample, the data was collected from one school whereas in Namibian sample from at least three schools. This imbalance in the number of sites could have had an influence on the results. Hence, these results must be limited in terms of generalising them on the entire population of either country cannot be generalised with all the Finnish science teachers; neither can they be generalised with all the Namibian science teachers. It has to be considered within the context in which the research was conducted.

7.5 Scientific contribution of the study to literature

Comparing teaching methods of Middle school science teachers between Finland and Namibia has provided literature of two educational systems where one is a developed nation and the other a developing nation. It fills the gap in knowledge of preferred Middle school science teaching methods extracted from two socially and economically different countries. For there
has been no such research on this issue that has been published on a comparative approach. The findings of this study set the foundation of recommendations on suitable Middle school science teaching methods according to the reasons for the choice of the respondents. Furthermore, the findings could be relevant for designing education reform as they have equally revealed the shortcomings of promoting learner-centred teaching methods over teacher-centred teaching methods. The study has provided a rich argument on the teaching approaches which informs how learning and teaching must take place generally. The research has shown clarity about the relationship between teachers’ perceptions and understanding of science education in both countries.

It informs the policymakers, middle school science teachers about the mismatch of time allocation with subject content especially for physical science in Namibia. It also informs the importance of continuous professional development for teachers. In this case, Namibia where some natural science and physical science teachers are finding it hard to implement the revised curriculum. Additionally, the study reveals the importance of piloting a revised curriculum especially when it undertakes significant changes. This is evident in the Namibian case where implementation of the revised curriculum seems to be not well operative due to the mismatched subject content and time allocation. Middle school physical science teachers are finding it hard to implement the curriculum properly due to lack of appropriate time allocation.

As equally argued by Awe and Kasanda (2016) and UNICEF (2011), this study revealed that Namibian middle school science teachers are coming short of fully implementing experimental teaching methods because of lack of science teaching materials. That still calls on the policy maker and the ministry of education to address this shortcoming.

### 7.6 Validity and ethical issues of the whole study

Validity in qualitative research is the assessment of how suitable the tools, processes, and data were for the study (Lawrence, 2015). It looks at whether the research question was valid for the desired outcome. It also analyses whether the methodology used was appropriate in answering the research questions. Furthermore, it assesses the research design if it was adequate for the choice of the methodology and data sampling. Finally, it evaluates if the results and conclusions are valid for the sample and context (Lawrence, 2015). Therefore, in probing and assessing what the researcher embarked on studying, the choice of the methodology was
appropriate. The data collection tool used was well developed in accordance with the research questions. The study was comparing a phenomenon in two countries. Thus the case-based cross-national comparative approach is the most aligned method of study in such a case (Vaus, 2008). As qualitative research, it focussed of the specific target group (Middle school science teachers) thus a purposeful sampling was the most probable choice. The results represent the reality of the situation as told by the respondents in their respective context. Therefore, the differences and similarities in the results between Namibian middle school science teachers and Finnish middle school science teachers can be taken as being true. The research design outlined the whole research process from the conceptualisation stage to data collection, data analysis and reporting stages which the research embarked on and followed.

In addition to the above constructs, validity examines the measure of trustworthiness of the value and effectiveness of qualitative research. It provides the needed thoroughness in a whole research process (Collier-Reed, Ingerman & Berglund, 2009). Therefore, it provides a comprehensive reinforcement of the research outcome and its impact. That is why as a qualitative researcher who applied social constructivism, trustworthiness has been considered as a matter of concern to the readers of these findings. These are the criteria that have been used to make this research trustworthy, credibility, transferability, dependability, confirmability, and authenticity (Loh, 2013; Collier-Reed et al., 2009).

*Credibility* refers to the truthfulness of the interpretation and representation of the data by the researcher and from the perspective of the participants (Cope, 2014). It is the truth-value of research and, it considers the correlation between the social constructs of the respondents and the researcher’s interpretation. In this investigation, a prolonged engagement between the researcher and the participants took place through the semi-structured interviews. After that, the collected data were destroyed after the publication of this research. The interpretation involved references to previous researches and direct citation of the respondents’ responses. In addition, in this research individual science teachers were capable of describing the different phenomenon in science education (Cope, 2014). The principle of *transferability* depends on the research task. Transferability, therefore, is the extent to which the findings of the research can be applied to other settings. The results of this study make sense and readers are capable of associating themselves with their own experiences especially science teachers. Readers can assess the findings because sufficient information on the respondents together with the research context has been provided.
Dependability is the extent to which a study can be repeated and still produce similar results if similar participants and conditions are maintained (Boudah, 2011). In reality though, if the credibility of research has been established, then the need for providing dependability is minimal (Collier-Reed et al., 2009). Confirmability is when the researcher can demonstrate that the data used in research genuinely represents the responses of the respondents and not his/her biases (Polit and Beck, 2012). Thus, this study’s confirmability has been demonstrated by the way the data has been presented and interpreted. The presentation clearly shows the responses of the participants whereas the discussion and interpretation include direct quotes from the participant's responses. Lastly, authenticity is the ability and extent to which “the researcher expresses the participant’s experiences realistically” (Cope, 2014; p. 89). In this research, the readers are capable of understanding the participants’ experience through the direct quotes used in the interpretation. The details of the participants’ experiences have been recorded according to their responses, see Table 6. Ethical considerations about the data collection process, analysis and dissemination of qualitative report, in this case, the publication of this study have been considered throughout the research. The researcher implemented the ethical guidelines for qualitative research as argued by Creswell and Poth (2018) which are respecting the participants’ privacy by obtaining their consent; maintained between the information that was provided to the participants to avoid unnecessary influence on the results, and fairness was applied in soliciting the needed data from the volunteered participants.
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Appendices of the study

Appendix A

RESEARCH ETHICAL STATEMENT

Dear participant(s)

It is your right to consent participation in this interview that forms part of Mr Mubiana Kelvin Katukula’s Masters’ degree research component of collecting data. The purpose of this interview is to gather information from teachers about their perceptions of preferred teaching methods in science subjects for junior secondary phase (middle school).

Therefore, involvement in this research is voluntary. Interviews will take approximately +30 minutes, and you are not obliged to respond to where you feel uncomfortable. Remember, this interview will be recorded and later transcribed into my research. I may be the only person with access to this information between now and the publication of my research of which participants will remain anonymous. No full or part of recorded interview shall be used for any purpose apart from intentions as mentioned here.

This study abides by all ethical standards for research at the University of Eastern Finland (http://www.uef.fi/en/tutkimusetiikka).

Your cooperation is highly appreciated

Faithfully,

Mubiana Kelvin Katukula

CONSENT FORM: INDIVIDUAL INTERVIEW

I, at this moment, acknowledge taking part in the individual interview(s) of this research. I am aware of my rights, voluntary participation or withdrawal from this exercise at any time. I grant the anonymous research excerpts of the interview.
Appendix B

Teacher Interview Protocol

Foreword.
The purpose of this interview is to gather information from teachers about their perceptions of preferred teaching methods in science subjects for junior secondary phase (middle school). It will take approximately 40 minutes.

Questions.
Please tell me a little about yourself as a teacher.

| Current Experience | 1. Would you mind telling me your educational qualification like (Dip, BA, MA or PhD)?
|                   | 2. What is your major and minor subjects?
|                   | 3. What grade levels do you teach?
|                   | 4. How long have been teaching at this school?
|                   | 5. Do you have other roles at the school (like the head of the department, subject head) in addition to science teaching? |

Part 2. Previous experiences and science perceptions
Please tell me more about your experiences and perceptions of teaching science

| Science experiences and perceptions | 1. How long have you been teaching science subjects?
|                                    | 2. In your science teaching experience, have you been co-teaching or developing lesson plans with a colleague or someone
|                                    | 3. How do you find science teaching (your perceptions of science education)? (views)
|                                    | 4. What are the main aims of science education at school?
|                                    | 5. What do you think of the current curriculum?
|                                    | 6. What is essential in teaching science and why?
|                                    | 7. Would you mind to tell me some of your teaching goals in science education?
|                                    | 8. What are the current challenges you are facing as a science teacher? |
### Part 3. School context and Teaching Methods

Please tell me a little about your teaching methods.

“Science teaching requires the application of different teaching methods.

<table>
<thead>
<tr>
<th>Teaching Methods</th>
<th>1. How do you understand this term teaching methods?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Would you tell me your preferred teaching methods?</td>
</tr>
<tr>
<td></td>
<td>2.1 Why do you use this/these methods and in what context?</td>
</tr>
<tr>
<td></td>
<td>2.2 What do you <strong>aim</strong> for when using this and or these teaching methods?</td>
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<td><strong>2.3</strong> In your opinion, are those aims in line with your teaching goals?</td>
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<td>2.4 How do you think these teaching methods affect learners’ (a) scientific skills (b) attitude &amp; interest (c) performance?</td>
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<td>2.5 Alternatively, are they for <strong>specific skills</strong> you would want your learners to develop?</td>
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<td>2.6 What kind of <strong>skills</strong> do you want your learners to develop by using this or these teaching methods? (<strong>observations skills</strong>, <strong>scientific process skills</strong>: communicating skills, classifying, <strong>measuring</strong>, inferring, and predicting)</td>
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<td>2.7 Could you please tell me, which among these methods you perceive as the most effective in yielding the best learning outcomes?</td>
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<td>2.8 Why do you think they are the best?</td>
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<td>2.9 Any benefits associated with the implementation of these teaching methods</td>
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<td></td>
<td>2.10 Any barriers associated with the implementation of these teaching methods.</td>
</tr>
</tbody>
</table>