Understanding how grade 11 Physical Science teachers mediate learning of the topic distillation in the Kavango Region

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DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and has not previously in its entirety or in part been submitted at any university for a degree.

Signature: .... Date..

Mr. Andreas Muronga Shifafure

ABSTRACT

The National Curriculum of Education was implemented with the broad view of including all learners as laid out in the document Toward Education for All. The curriculum emphasised that the topic distillation should be studied. According to the Examiners Reports, the topic distillation is one of the topics where learners face difficulties in the Namibian Senior Secondary Certificate Ordinary (NSSCO) examination Grade 12.

This led me to do research on understanding how Physical Science teachers mediate the topic distillation in Namibia specifically in the Kavango region. The study was carried out at two rural schools with two teachers teaching Grade 11. The community member who I asked to demonstrate the making of *Kashipembe* was also a participant during this study. *Kashipembe* is a local cultural brew alcohol beverage commonly made in the Kavango East and West Regions of Namibia, which was used as a learning context in this research study.

The study used a qualitative case study underpinned by an interpretive paradigm. Data was generated through the use of document analysis, semi-structured interviews, stimulated recall interviews, lesson observations, brainstorming and practical demonstration of making *Kashipembe*. These different methods of data gathering were used with the aim of triangulating and validating the data. Therefore, my theoretical framework adopted Vygotsky's (1986) mediation of learning, social constructivism and pedagogical content knowledge according to Shulman's (1986) theory. The emergent themes were identified inductively and they were colour coded. These themes were later developed into analytic statements which were used in the study.

The findings indicate that the use of community knowledge and experience during the teaching of scientific concepts like distillation is important. These findings can also be used by the practising teachers to make their teaching more effective in the curriculums where distillation is included. Therefore, the Namibian curriculum developers need to include this community knowledge in the curriculum to make it easier for the learners to make sense of the topic distillation.

ACKNOWLEDGEMENTS

First and foremost, a ride has come to its end, and in the last moments of proofreading and editing this thesis, I have come to realise there are several people who deserve my gratitude.

Special thanks are due to my supervisors Dr. Kenneth M. Ngcoza and Dr. Charles Chikunda as well as the Master of Science Education Coordinator Mr. Robert Kraft for their wonderful and tireless support throughout this journey. It has been wonderful working with them, and they taught me many things during my two years of part time study through Rhodes University. I have enjoyed their enthusiasm, spirit, and support throughout the two years. But above all I have been able to take from them some particularly important lessons which are: patience, honesty, support for one another and sacrifices, because with them everything was possible.

I appreciate the support I received from the school managers, teachers, the community member and the learners whose assistance has helped to make this thesis a reality.

Lastly, I also thank my family and my friends most sincerely who have supported me in all of my comings and goings throughout these years. There were times when I was uncertain about my occupation and the lack of resources. But I found that their continuous inquiries about my career helped me immensely. For that I am grateful.

DEDICATION

This thesis is dedicated to my wife (Kasekere Magdalena Shifafure), my daughter (Mudi Brigitha Shifafure) and my sons (Andreas Muronga Shifafure & Rafael Shifafure) and my family. They all care about my wellbeing and were very encouraging throughout this study.

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LIST OF ABBREVIATIONS AND ACRONYMS

CMR	Community Member’s Responses
EHDC	Education High Degree Committee
ESL	English as a Second Language
FQ	Follow-up Question
GCSE	General Certificate of Secondary Education
IK	Indigenous Knowledge
IQ	Interview Question
LCE	Learner-Centred Education
LoLT	Language of Learning and Teaching
LTSMs	Learning and Teaching Support Materials
MOE	Ministry of Education
NAMCOL	Namibian College of Open Learning
NGOs	Non-governmental Organisations
NIED	National Institute for Educational Development
NNCBE	Namibia National Curriculum for Basic Education
NSSCO	Namibian Senior Secondary Certificate Ordinary
NSSCO/H	Namibian Senior Secondary Certificate Ordinary/Higher
PCK	Pedagogical Content Knowledge
PEEOE	Predict Explain Explore Observe and Explain
PEK	Prior Everyday Knowledge
PW	Practical Work
RT	Researcher’s Translation
SADC	Southern Africa Development Countries
SRI	Stimulated Recall Interview
TRC	Teachers Resource Centre
TIMSS	Trends in International Mathematics and Science Study
UK	United Kingdom
ZPD	Zone of Proximal Development

SYMBOLS USED IN THE STUDY

^{0}C	Degree Celsius
%	Percentage

CHAPTER ONE: BACKGROUND TO THE STUDY

> *The foundations of qualitative research begin with a brief introduction to the philosophical underpinnings, history and traditions of qualitative research. This is not intended as a comprehensive or detailed account, but rather as edited highlights of some of the key issues in an ever advancing process. There are several reasons why it is helpful to understand something of the background of qualitative research before going on to discuss the specifics of how to do it (Ritchie, Lewis, Nicholls & Ormston, 2013: 2).*

1.1 Introduction

The main goal of this study was to understand the teaching strategies that grade 11 Physical Science teachers use when teaching the topic distillation in the Kavango Region. This study was triggered by the fact that as a Grade 8-12 Physical Science teacher I observed that learners struggle with the concepts related to distillation. This is exacerbated by the fact that learners have little or no prior everyday knowledge about the distillation processes including information gained from earlier grades. It is for this reason that effective teaching strategies to make sense of the concepts related to distillation are necessary.

The first section of the chapter outlines the requirements of the Namibian science curriculum; this is followed by a sketch of the background to the study and its potential value for education in Namibia. Additionally, the goal of the study, the research questions as well as the data gathering techniques I employed are discussed. Concepts on distillation are also explored. Lastly, the key concepts used in the study and an outline of the thesis are provided. The chapter ends with some concluding remarks.

1.2 The Namibian science curriculum

This presents a review of the science policy for Namibia as laid out in the National Curriculum of Basic Education (Namibia. NCBE, 2010b). This policy acts as a guide for teachers of Physical Science; however, I pay attention to science in particular. The policy is relevant to my study as teachers follow it to teach practical topics such as distillation for assessment purposes.

According to the Namibian National Curriculum for Basic Education (210b), the curriculum provides guidelines for educational planning, organising and implementing content. Furthermore, it is the responsibility of all schools and educational institutions catering for full-time and part-time learners to ensure that they satisfy the requirements of this curriculum, and those specified in the syllabi and other curriculum documents for each phase and subject in Basic Education.

The NCBE (2010b) states that the Namibian Natural Sciences learning area comprises Environmental Learning (Pre-Primary) Environmental Studies (Grades 1-4); Natural Science and Health Education (Grades 5-7); Elementary Agriculture (Grades 5-7); Life Science (Grades 8-10); Agriculture (Grades 8-12); Biology (Grades 11-12); and Physical Science (Grades 8-12).

> Science teaching should be continuous throughout the period a learner is in school. From the days at primary school to the final Namibia Senior Secondary Certificate examination in the high school the learner should have had a constant scientific strand running through his/her school calling. This will all depend on how teachers are teaching the topic in various subjects of science for learners' understanding… (Namibia. Physical Science Subject Policy Guide Grades 8-12 (2008: 1-2).

The science curriculum should be designed as a set of learning arranged in a way that consider learners' everyday knowledge and makes use of this knowledge to build on school knowledge (Stears, Malcolm & Kowlas, 2003: 3).

1.3 Context to the study

1.3.1 International context

My study is contextualized by looking first at the international Trends in International Mathematics and Science Study (TIMSS). Martin, Mullis, Gonzalez and Chrostowski (2003) state that TIMSS is a project of the International Association for the Evaluation of International Achievement (IEA). This are groups of stakeholders for national research institutions and different government agencies that conduct cross studies of national achievement starting from 1959. The primary purpose of TIMSS is to improve the teaching and learning of mathematics and science by providing data about students' achievements in relation to different types of curricula, instructional practices, and school environments. The variation across the nearly 50 participating countries provides a unique opportunity to study different approaches to educational practices and how these can improve achievement. It emerged from the TIMSS that the chemistry concepts still remain a challenge in terms of achievement by participating countries.

The TIMSS (2003) report highlighted that teachers and the teaching strategies they use determine in part what the science learners learn. Furthermore, the teachers' planning of the lessons, pacing of the lessons, introduction of new materials and monitoring learners' learning development enhances the understanding of the science contents being taught. The teachers may help the learners to use the technology and tools to investigate scientific ideas, look at learners' work and point out misconceptions and promote a positive attitude towards science (ibid). For instance, the apparatus used to carry out distillation should be organised and explained by the teachers in order to assist learners to understand and make sense of the topic of distillation. In my case study, my research is oriented towards understanding the teaching strategies that science teachers use when teaching the topic distillation in the classroom set-up.

1.3.2 Namibian context

The Namibian Senior Secondary Certificate Ordinary/Higher (NSSCO/H) syllabus for Physical Science is designed as a two-year course leading to an examination after the completion of the Junior Secondary Certificate. This syllabus is divided into Physics and Chemistry sections with suggested practical work required for each component. For instance, the aims of (NSSCO) Physical Science (2009: 2) include some of the following: To provide, through well designed studies of experimental and practical science, a worthwhile educational experience for all learners, whether or not they go on to study science beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge to recognize the usefulness and limitations of scientific methods and to appreciate its applicability in other disciplines and in everyday life.

According to Sneyder (1998), science teaching in Namibia is basically theoretical and the teaching of practical work is neglected in most secondary schools. That is, it could be argued that the teaching of science is still dominated by theory driven instruction that also relies heavily on rote learning as a way for students to acquire scientific knowledge. Consequently, while some learners progress in science, the majority fail it because they are not exposed to real live practical science. This could be one of the reasons why the practical topics including distillation, which is the focus of this study, are being performed badly, especially in rural schools in Namibia.

In my pilot interview with one of the Master of Science education students, she maintained that her Grade 12 Physical Science learners do not perform well in the external examination in the topic distillation which requires practical work. She indicated that the Namibian syllabus is not sufficiently detailed on experimental techniques. She was also of the opinion that teachers' styles of teaching, teachers' subject content knowledge and scientific language might be contributing factors leading to the poor results in the practical components of the syllabus.

The NSSCO Examiners' Reports (2008-2012)state that "*the teachings of practical topics which include concepts on distillation in, both ordinary and higher levels, are problematic as it is revealed by learners' performance*". Further comments state that, "*learners usually perform [more] poorly in most Chemistry practical components than in other Physical Science sections of Physics in paper 2 and paper 3*". For example, "*most learners did not do well in the written paper of compulsory questions designed to test familiarity with practical laboratory procedures which tested skills on practical topics*". Furthermore, "*learners' performed poorly in the topics involving practical activities similar to concepts on distillation when asked in the final question paper*". The NSSCO Examiner's report (2008) highlighted that a majority of Namibian schools examination candidates reveal that too little or no practical work was done on the topics of distillation. According to the Examiner's report (2010):

> "Most learners could correctly identify the process of distillation on [the] figure but failed to express the concepts around distillation process. Fractional distillation, although discussed in grade 10 was not known and identified by the learners. Many repeated the question instead of answering the question, e.g. stating that the salt dissolves. Not many learners could obtain full marks for this question on distillation processes. Learners could not identify the correct apparatus; many had labels such as 'beaker/jar' instead of 'conical flask or Erlenmeyer flask'. Furthermore, quite a number of learners misunderstood the question. They tried to describe the figure in (b) e.g. 'filtration', instead of 'distillation'. Misunderstanding of simple distillation and fractional distillation is a concern; this resulted in many learners confusing fractional distillation and simple distillation. Most learners mentioned only evaporation, retrieving only the salt and not the solution".

Thus, for many schools, their students' work revealed that little or no practical work on distillation was done and that components of the syllabus were taught superficially and without understanding or not taught at all (Questions 6, 7 and 9) (NSSCO Examiner's report, 2011: 397). I now describe what distillation is below.

1.3.3 The topic distillation

Distillation is essentially a process of turning a liquid into a vapour and then condensing the vapour and recovering the liquid. Uushona (2012: 23) defined distillation as a method which has to do with separation of mixtures through vaporization and it involves boiling the mixture and then condensing the vapour that forms into liquid. Every liquid has a different boiling point and thus in the case of a mixture the liquid with the lowest boiling point would evaporate first and then each can be recovered by allowing it to condense at a different moment or level.

School science students need to understand this principle and the related concepts, and they are also expected to do mini-practical distillation experiments. Because distillation is a central process in many every day and industrial applications it is a necessary part of a typical science curriculum.

A multi-component mixture is separated due to a difference in volatility, and hence a distribution of the components between the vapour and the liquid phase. The vapour phase is created from the liquid phase by vaporization at the boiling point. The ease of a distillation separation process depends on the volatility of the components and in turn their boiling points (Haugen, 2007).

According to Valanides (2000), distillation of a water solution also seems to depend not only on whether primary and secondary teachers realize that water contains dissolved solid(s) (i.e., in tap water), but also on the nature of the dissolved solid (sugar or salt), or on the nature of the dissolved substances (solid or liquid, coloured or colourless solution).

Everyday examples of distillation would be the separation of water and salt in the case of brackish or sea water so that one can have both for useful use. Namibia is a leader in the purification of sea water or the purification of contaminated water. One of the main industrial uses of distillation is in the petro chemical industry. In the petro chemical industry they use a fractional distillation process, which uses distillation columns. Using very high temperatures they boil all the liquids and as the vapour moves up the destination column it is allowed to condense. The liquid with the highest boiling point condenses first and usually at the lowest point in the column while the liquid with the lowest boiling point would condense last at the top of the column and all the others will be in layers in between.

It is against this background that I was motivated to investigate the teaching strategies that grade 11 Physical Science teachers use when teaching the topic on distillation. There is scant information available about actual Namibian teachers' classroom practices when teaching the topic on distillation. We observe the results at the national examination level and draw reasonable inferences from these. But clearly direct observation and interrogation of teachers' practices and understandings is now needed if we are to move forward on this issue.

1.4 Potential value of the study

The potential value of this study is in relation to the teaching strategies used by Physical Science teachers when teaching the topic on distillation. This study might help teachers to know and understand that using different teaching strategies is useful for better conceptual understanding. The invitation of the community member to do a demonstration of *Kashipembe* could serve as a model on how to incorporate indigenous knowledge (IK) during science lessons as a strategy to contextualise and make science relevant to the learners' everyday lives.

Kashipembe is a traditional alcoholic beverage which is obtained from fermenting and cooking the contents of mangetti fruits in Kavango East and West regions. This practical demonstration was presented as part of Phase two in this study. In hindsight, this also made community members to realise that our education system values their practices; therefore, science teachers need to explore how they could tap into this knowledge. Moreover, learners could be helped to see and understand that scientific knowledge is part of their everyday lives.

Furthermore, this study is of importance as it could be helpful for the curriculum developers in Namibia in offering some further insights into the nature of teaching strategies and practices of science teaching in the Namibian context. The case study was located within a rural school set up where there is often a lack of science equipment and so insights into the nature and consequence of this were highlighted. The study could thus inform Physical Science teachers to better understand the teaching strategies associated with the topic on distillation. Finally, it is hoped that the study would also improve my own teaching practice as a science teacher by offering me the opportunity for reflection.

1.5 Theoretical frameworks

A theoretical framework in social learning enhances the awareness of observable facts and provides a platform for argumentation over existing knowledge and opens a route for the construction of new knowledge to be formed (Homateni, 2012). This study, on the understanding of teaching strategies that grade 11 teachers use when teaching the topic distillation was aided by theoretical frameworks borrowed from Vygotsky's (1978) mediation of learning and social constructivism in conjunction with Shulman's (1986) pedagogical content knowledge (PCK). The chosen theoretical frameworks helped me as a researcher to understand how teachers teach this topic distillation.

1.6 Goal of the study

The main goal of this study was to understanding how grade 11 Physical Science teachers mediate learning of the topic distillation in the Kavango Region. To achieve this goal, the following main research question and sub-questions guided the study.

1.7 Research questions

1.7.1 Main Research Questions

What teaching strategies do grade 11 Physical Science teachers use when teaching the topic distillation?

1.7.2 Sub-questions:

- In what ways do grade 11 Physical Science teachers help learners make sense of the concepts on distillation?
- What factors enable or constrain learners from making sense of concepts on distillation?

To answer the first and second sub-question in Phase 1, I analysed documents, conducted interviews with my participants (teachers) and did three lesson observations for each teacher while they were teaching distillation. At the end of the three lessons a test was written by the learners.

- In what ways can grade 11 Physical Science teachers improve their teaching strategies when teaching the topic distillation?

This question in Phase 2 was answered through discussions and reflections with my research participants on their lessons on distillation and as a result, two model lessons were developed which were informed by data from the stimulated recall interviews which guided us in enhancing and improving the teaching of distillation concepts. An enriching factor was the integration of contextual scientific knowledge in the classroom with community knowledge of the making *Kashipembe* which was videortaped. Lastly, a unit of work was co-developed and used by the two teachers when they taught the distillation topic which aimed at enhancing the sense making of concepts on distillation.

1.8 Data gathering techniques

The following data gathering techniques were used in this study:

- Document analysis;
- Observation;
- Interviews (semi-structured and stimulated recall interviews); and
- Brainstorming and discussions.

A variety of data gathering techniques were used with a view to enhancing the validity and trustworthiness of the data gathered through the triangulation of methods as proposed by Maree (2012: 80).

1.9 Definition of concepts used in the study

Following is a list of short definitions of some concepts used in this thesis most of which are on the topic distillation.

- **Boiling point** is the highest temperature at which a substance can change its state from a liquid to a gas. E.g. water boils at 100 ^{0}C and alcohol at 78 ^{0}C.
- **Condensation** is when vapour changes to liquid.
- **Distillate** is the purified liquid which is collected in a receiver during distillation, for example, ethanol.
- **Distillation** is the process of boiling a liquid and then condensing the vapour produced back into a liquid. It is used to purify liquids and to separate mixtures of liquids.
- **Evaporation** is when liquid changes to gas.
- **Fractional distillation** is a process that separates more than one substance at a time, it is used when boiling points are different or when mixtures are complex (e.g. ethanol and water). These can be separated since they both have different boiling points.
- **Immiscible** refers to substances that do not mix easily e.g. oil and water.
- **Indigenous Knowledge** is a legacy of knowledge and skills unique to an exacting indigenous culture and involving wisdom that has been developed and passed on over generations.
- **Insoluble** is the inability of a substance to dissolve into another substance.
- ***Kashipembe*** is a local cultural brew alcohol beverage commonly made in the Kavango East and West Regions of Namibia, which was used as a learning context in this research study.
- **Mediated learning** is the action of social interaction between teacher and learner in the enrichment of the student's learning experience.
- **Mediation -** A bridging process /method used by the teacher in scaffolding learners to access and make sense of subject content.
- **Miscible** when substances can mix with each other. E.g. ethanol and water.
- **Mixture** is the composition of different substances liquid and liquid, solid and solid or liquid and solid.
- **Practical work** these are the activities which learners and teachers do with hand-on materials to enhance the teaching and learning process.
- **Prior everyday knowledge** is the kind of knowledge which the learners possess about various topics in school sciences.
- **Sense-making** - the ability of learners to connect scientific language and concepts to their already existing knowledge in real life situation.
- **Soluble** the ability of a substance (*liquid*) to dissolves into another substance (*liquid*).

- **Solution** is a mixture of a solute and solvent. E.g. sugar into water.
- **Solvent** substance into which another substance dissolves. E.g. water.
- **Simple distillation** the simple separation of a solid and a liquid by evaporating the liquid and collecting it after it passes through a condenser to be changed into a liquid state.
- **Zone of Proximal Development** is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance.

1.10 Thesis outline

The thesis is comprised of seven chapters and its structure is arranged as follows:

Chapter One: Background to the study

This introductory chapter informs the reader about the study. Firstly, the chapter discussed the science curriculum and context/background of the study both internationally and in the Namibian context. This was followed by the potential value of the study, the theoretical frameworks informing the study, the goal of the study as well as the research questions. The last part describes my data gathering techniques, definitions of concepts, the thesis outline and some concluding remarks.

Chapter Two: Literature review

This chapter provides a review of the literature relevant to this study. The literature used was based on the concept of distillation; teaching strategies; practical work; prior everyday knowledge (PEK); indigenous knowledge (IK); as well as the theoretical frameworks used in the study, namely, Vygotsky's mediation of learning and social constructivism in conjunction with pedagogical content knowledge (PCK). I end this chapter with some concluding remarks.

Chapter Three: Research methodology

This chapter describes the research paradigm which informed this study, which is followed by the research goal and questions. The research sites, participants, data gathering techniques, data analysis and analysis framework are discussed. Additionally, validity, ethical issues or considerations and limitations of the study are debated. It ends with some concluding remarks.

Chapter Four: Data presentation Phase One

In this chapter, I present data from Phase One which is a narrative account of the data that have been generated using document analysis, observations, semi-structured interviews, stimulated recall interviews, learners' workbooks and field notes. The presentation was mostly in the respondents' own words and the chapter ends with some concluding remarks.

Chapter Five: Data presentation Phase Two

In this chapter, I present the data from Phase Two. This data came from brainstorming and discussion on *Kashipembe* as well as the development of the model lesson on distillation. It was aided by semi-structured and stimulated recall interviews with learners and a community member. Practical activities on the distillation process through a demonstration of making *Kashipembe* by a community member served as the integration strategy of community knowledge with school science.

Chapter Six: Data analysis, interpretation and discussions

In this chapter I present and examine the findings which emerged from the main themes which were derived through coding from data presented in Chapters 4 and 5. In my discussion I integrated literature from Chapter 2 with reference to my main research question and sub-questions.

Chapter Seven: Summary of findings, recommendations and conclusion

This chapter concludes the study. It presents a summary of the findings. Recommendations based on the research and areas for future research are given as well as the limitations of the research. I end this chapter with brief personal reflections based on my journey during this process.

1.11 Concluding remarks

In this chapter I outlined the context and background of the study. The chapter further presented the potential value of the study, theoretical frameworks, goals of the study, research questions, data gathering techniques, the definition of concepts used in the study and the thesis outline.

The next chapter presents the literature reviewed in relation to understanding the teaching strategies that grade 11 Physical Science teachers use when teaching the topic distillation.

CHAPTER TWO: LITERATURE REVIEW

> *The purpose of a literature review is to give credibility and legitimacy to the research, showing readers that the researcher has 'done his/her homework' and knows the up-to-date, key issues, and the theoretical, conceptual, methodological and substantive problems in the field in which the research is being proposed (Cohen, Manion & Morrison, 2011: 112)*

2.1 Introduction

The main goal of this study was to understand how grade 11 Physical Science teachers mediate learning of the topic distillation in the Kavango Region. As pointed out by Cohen, Manion and Morrison (2011) in the epigraph, the purpose of literature is to review other research to get theoretical ideas about what others have said about the concept under study. The literature reviewed in this chapter is therefore in relation to the teaching of the topic on distillation.

In this chapter, I thus discuss the concepts in relation to distillation which include: use of teaching strategies, use of practical work, use of learning and teaching support materials (LTSM), eliciting of learners prior everyday knowledge (PEK) and use of indigenous knowledge (IK) to make sense of the concepts underpinning the topic distillation. The study is informed by the theoretical frameworks of mediation of learning written mostly by Vygotsky (1896-1934), social constructivism as described by Vygotsky (1978) and supported by the pedagogical content knowledge (PCK) of the science teachers as described by Schulman (1987). I now discuss each of these in detail.

2.2 The concepts of distillation

Valanides (2000: 356) points out that distillation is related to several physical changes, such as evaporation, boiling, vapour condensation, and the water cycle in nature. In addition to the understanding of the process of distillation and some closely related concepts, such as boiling point or latent heat of evaporation, this will provide useful information concerning the comprehension of the particulate nature of matter and its transformations.

In his study conducted in the University of Cyprus, Department of Educational Studies, Valanides explained the concepts of distillation as they are usually introduced to primary school students, while in the early secondary school, teachers demonstrate distillation and in some cases students carry out distillation themselves. The procedures of distillation and fractional distillation are common separation techniques, which may be reintroduced to secondary school students several times. These techniques are demonstrated using thermometers and the usual glassware. Furthermore, Valanides (2000) argued that distillation of a water solution seems to depend not only on whether primary and secondary teachers realize that water contains dissolved solid(s) (i.e., tap water), but also on the nature of the dissolved solid (sugar or salt), or on the nature of the dissolved substances (solid or liquid, coloured or colourless solution).

The ease of a distillation separation process depends on the volatility of the components and in turn their boiling points (Haugen, 2007). Moreover, distillation is a very old technology for separating liquid mixtures that can be traced back to the chemists in Alexandria in the first century A.D. Today distillation is the most important industrial separation technology. It is particularly well suited for high purity separations since any degree of separation can be obtained with a fixed energy consumption by increasing the number of equilibrium stages. However, the Namibian syllabus for grade 10 does not expand the topic distillation to the concept of equilibrium.

For instance, the Namibian Senior Secondary Certificate Ordinary Syllabus (Namibia. NSSCO, 2009) states that it is important that throughout the chemistry section learners should understand the principles of experimental techniques and be able to describe methods of purification by the use of a suitable solvent, filtration, crystallization, re-crystallization and distillation (including use of fractionating column) (p. 23). Furthermore, the syllabus encourages teachers to teach learners so that they can understand the topic by gaining skills and knowledge through practical activities suggested under the experimental techniques. It is for these reasons that I decided to focus this study on the understanding of teaching strategies that grade 11 Physical Science teachers use when teaching the topic on distillation.

Distillation is the process of boiling a liquid and then condensing the vapour produced back into a liquid. It is used to purify liquids and to separate mixtures of liquids (Earl &Wilford, 1995: 27). Hill (1986) added that distillation involves evaporating a liquid and condensing the vapour. Lending support to this idea, Uushona (2012: 23) defines distillation as a method which has to do with separation of mixtures through vaporization and it involves boiling the mixture and then condensing the vapour that forms into liquid.

For example, water can be obtained from salt water (a solution) by distillation through methods of purification. Distillation is most commonly used to separate two or more liquids from each other, and this is done in two processes which are simple distillation and fractional distillation. This is one of the reasons for including the traditional demonstration of making *Kashipembe*, to serve as teaching strategy which leads to a better understanding of distillation concepts by learners.

Simple distillation is an example of purifying substances. That is, simple distillation is a process used in chemistry to get pure solvent out of a solution (Gallagher & Ingram, 1989: 20). Gallagher and Ingram give the example that water can be obtained from salt water using simple distillation by heating the solution in the flask until it boils. The steam rises into the Liebig condenser, where it condenses back into water, and then the water drips into the collecting beaker where it is collected as distillate.

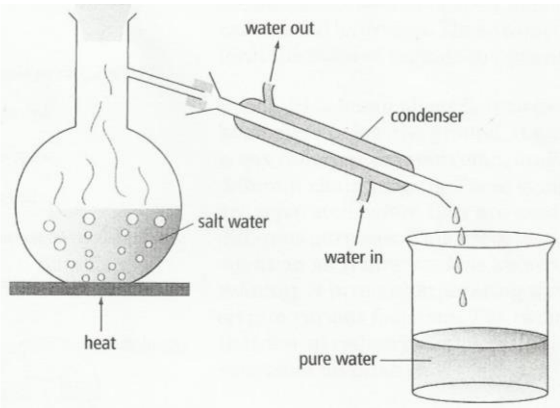


Figure 2.2. (i) Process of simple distillation (Kachinda & Ajayi, 2009: 11)

According to Earl and Wilford (1995), fractional distillation is a purification process which relies upon the liquids having different boiling points. It is used to separate miscible liquids (miscible refers to liquids which mix together). They gave the example that when the mixture of ethanol and water is heated the vapours of ethanol and water boil at different temperatures and can be condensed and collected separately. For instance, ethanol boils at about 78^0C whereas water boils at 100^0C. After the mixture is heated the vapour produced is mainly ethanol and some steam.

Earl and Wilford (1995) further assert that because the water has a higher boiling point, it condenses out from the mixture with ethanol and this is exactly what takes place in the fractionating column. The water condenses and drips back into the flask while the ethanol vapour moves up the column and into the condenser, where it condenses into liquid ethanol (distillate) and is collected in the receiver (beaker). When all the ethanol has distilled over, the temperature reading on the thermometer rises steadily to about 100^0C, indicating that the steam is entering the condenser. As it reaches this point the receiver can be changed so that condensing water can be collected.

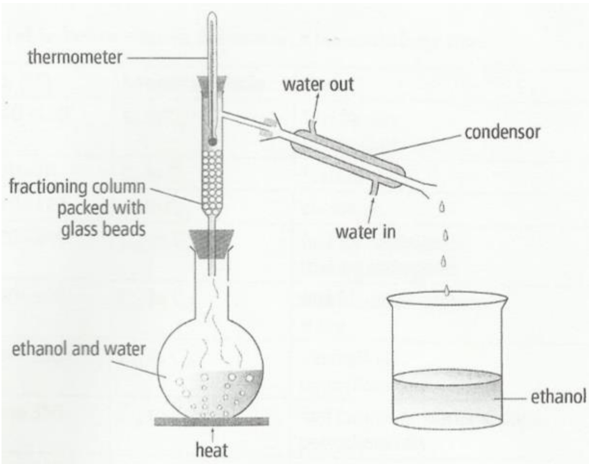


Figure 2.2. (ii) Process of fractional distillation (Kachinda & Ajayi, 2009: 12)

Research carried out in Europe at the University of Cyprus by Valanides (2000: 355) revealed some of the challenges science teachers experienced when teaching the topic distillation. Valanides stated that the majority of the learners have difficulty in noticing the effects of distillation on a water solution. For example, that the distillate would not change taste and colour, or that the taste and the colour would be lighter. These difficulties became progressively greater for a salt solution, a sugar solution, tap water, aqueous alcoholic solution, tea, and coke or wine. Valanides further pointed out that learners did not develop appropriate conceptions related to boiling point, latent heat of evaporation, and fractional distillation due to their limited understanding of the particulate state of matter. All these rely on planning and teaching strategies which science teachers should use when teaching the topic so that the topic could be understood.

New technologies help the teachers to make the teaching of distillation more understandable to the learners. However, some teachers are unable to employ them due to a lack of knowledge and skills in carrying out experiments. The scientific terms around distillation remain problematic for teachers and learners in both pronouncing and spelling when writing scientific reports. The apparatus is not easily set up if the teachers have never used them before which hampers the teaching and understanding of the topic. Lack of learning and teaching support materials (LTSMs) (Czernierwicz, Murray & Probyn, 2000) is also an obstacle in teaching this topic practically. That is, the unavailability of LTSMs used to teach distillation may also have an effect on conducting the practical activities on topics like distillation. The next section focuses on the teaching strategies used by teachers when teaching topics such as distillation.

2.3 Use of teaching strategies

In this section I review some literature concerning teaching strategies to provide insight into how teachers should teach the topic distillation to make it clearer to the learners. Teaching strategies have to do with the various methods used by a teacher to teach the lesson. A study carried out in New York revealed that science teachers need to find effective strategies for activating students' motivation levels to improve their understanding and cultivate life-long learners (Keith, 2006: 10). Furthermore, these authors feel that this is an issue of great importance for the future improvement of the teaching of subjects.

Ogunmade (2005) presented that teaching basically involves the knowledge teachers possess on subject content and methods they use, knowledge of the curriculum and efficient control of classroom management as well as self reflection to improve the learning outcomes of the learners. He further argued that teachers should plan, implement and assess students' engagement in meaningful science teaching that is active, relevant, developmentally appropriate, and build on students' prior knowledge through the use of activities that are inquiry-oriented, support the social construction of accurate science knowledge, and develop a sense of classroom community.

According to the Namibian subject policy guideline for Physical Science (2008), teachers should be creative at all times to make their own teaching and learning materials relevant to practical activities in science topics like distillation by using different teaching styles. The policy further states that, Physical Science is a subject through which the mysteries of the physical world around us are disclosed and basic laws are exposed. It should therefore be the target of every science teacher of any science subject to create an exciting, interesting and encouraging learning environment. Thus, this document outlined that the way in which teachers organise their teaching in classrooms and activities will have an effect on the atmosphere in the classroom as well as the activities.

> The challenge in teaching and preparing learners for a knowledge-based society is to provide well-managed flexibility in the approach to teaching and learning, and provide learning experiences which motivate the learner to learn more. The curriculum further stresses that teaching strategies must therefore be varied but flexible within well-structured sequences of lessons: learner-centred education does not mean that the teacher no longer has responsibility for seeing that learning takes place. It means that the teacher has to take on a wider repertoire of classroom roles … (Namibia. National Curriculum for Basic Education, 2010: 26).

The second teaching strategy science teachers use to teach the topic distillation is practical work. I will now discuss practical work as one of the vital tools in enhancing teaching and learning.

2.4 Use of practical work

Practical work is a strategy which makes science teaching more effective if practiced correctly and is pitched at the level of the learners. Therefore, I have investigated various sources to see what other researchers have written about practical work and how teachers understand and use it to teach learners, and in particular, the topic of distillation.

Ever since the method of experimental science was advocated in the sixteenth century it has been accepted that practical activities are the major assignment of scientists. As a result, scientists believe that learners should learn by doing what scientists do and that is the way we can educate future leaders (Klainin, 1995). Klainin outlined that learning science is seen by science educators as likely to be more effective if the child is involved in practical teaching and takes an active part in the learning process. He added that practical work has been a prominent feature of school science teaching from the late nineteenth century when science was established as part of the curriculum of schooling in a number of countries. Nonetheless, if learners do not witness science as a real-life practice, they are likely to experience difficulty in learning science and become disinclined to study it (Oloruntegbe & Ikpe, 2011: 266).

Tamir (1991: 14) explains the curriculum innovation of the 1950s which started in the United States of America and Europe and spread rapidly throughout the world. These innovations greatly changed the way science was taught. He further explains that at the international science conference, funds were made available to develop courses that would allow students to work like practicing scientists, by allowing learners to interact with the learning environment and this is one of the reasons why practical work has become a unique feature of science teaching.

In a study carried out in Laos Sweden by Vilaythong (2011: 7) indicated that practical work is any teaching and learning activity that involves at some point the students in observing or manipulating real objects and materials. He further emphasised that such understanding also coheres with the tradition of interpreting the meaning of practical work in the Lao educational system that includes students' handling of equipment and materials by themselves or watching the teacher handle equipment and materials. He further asserts that laboratory work includes learning experiences in which learners interact with learning materials to confirm and watch phenomena in a laboratory setting. Hence, practical activity is a didactic method for learning and practicing all the activities involved in carrying out the practical inquiry relevant to one's profession.

Millar (2004) points out that when a practical activity is well designed, it is likely to provide a scaffold for learners and thereby help them to make connections between their prior everyday knowledge (PEK) with the environment of science where PEK is elaborated in detail. Abraham and Millar (2008: 1945-1946) explain that in many countries, one of the features of science education that sets it apart from most other school subjects is that it involves practical work in which the learners use and observe real objects and materials. They further state that in countries with a tradition of practical work in school science like the United Kingdom (UK), practical work is often seen by teachers and others (particularly scientists) as central to the appeal and effectiveness of science education.

In the Namibian Physical Science syllabus (2008: 6), science is often seen as difficult, boring and as a consequence, produces poor results. In addition, certain prejudices still exist in this syllabus and with a little effort Science fairs, clubs, competitions and quizzes can be organised. Institutions and organisations have already developed material that can be used in these events. Opportunities should be created to allow learners to practice their skills and the syllabus requires that the learning process may be amplified by linking Science to real-life situations and hands-on practical activities in our environment.

Added to this, the Namibian syllabus for Physical Science (2009) includes a practical to coursework component in the general teaching of science. For instance, learners in Grades 11 and 12 are expected to do practical work as part of their examination to assess their scientific skills. Furthermore, just as scientists need laboratories to carry out their investigations, schools also need laboratories or special rooms in which students can carry out experiments (Nghipandulwa, 2011). This in itself implies that science teachers should plan in advance for the practical work to be conducted in their subjects at a reasonable time. The following Section 2.5 discusses the role of learning and teaching support materials (LTSMs).

The role of using readily local available materials to do demonstrations helps the learners to understand the topic distillation better than just theory. Therefore, science teacher should improvise at all times when necessary to makescience learning fun and educative at the same place.

2.5 Use of learning and teaching support materials (LTSMs)

Learning and Teaching Support Materials (LTSMs) are prepared materials which structure and support learning and teaching (Czerniewicz, et al., 2000: 20). Czerniewicz, et al. (2000) further explained that materials can be prepared by teachers in schools as well as by other educationalists in NGOs, publishers and other institutions. In their preparation and presentation of lessons many teachers do not make a clear difference between the role played by the learning programme (materials which frame the learning programme) and worksheets, games, puzzles and activity manuals (materials which are supplementary and practical or ‘hands on’ in support of the learning programme (ibid).

Teachers also need to consider various appropriate learning approaches and be aware of the differences in their learners’ capabilities to construct knowledge as this will inform the teacher how to teach effectively and how to use LTSMs in teaching and learning (Mdlungu, 2006: 32). Mdlungu stated that science teachers use learning and teaching support materials (LTSMs) such as maps, wall charts, flip charts, flash cards, scientific models, kits and toys, audio tapes and other technologies to support teaching and learning in science subjects.

According to Haury and Rillero (1994), teachers who use LTSMs during science teaching seem to recognise some learners' outcomes and use a learner-centred approach during their teaching. This would mean that the learners are more involved in the learning process and not the recipients of rote learning and teaching. In addition, these authors state that research has confirmed many of the benefits of LTSMs which have other unanticipated benefits. Nyambe (2008: 23) posits that learner-centred education (LCE) in post-apartheid Namibia embodies the slogan Education for All.

Nyambe argued that learner-centred education is supposed to foster successful learning for all learners by taking their existing knowledge, skills, interests and understanding- derived from their previous experiences in and out of school. Additionally, the National Institue for Educational Development (NIED) document (2003) states that the improvement of the quality of learning in Namibian classrooms should be realised through the correct and continuous application of learner-centred education (LCE). Teachers should have a good repertoire of knowledge about the subject they teach so that they can guide learners on the content of science learning (ibid).

Haury and Rillero (1994) stressed that learners using LTSMs during teaching science lessons could remember the material better, feel a sense of completion when the task was concluded, and were able to transmit that experience more easily to other learning situations. This only happens when the teacher uses LTSMs correctly during the teaching of concepts like distillation in the science classroom. The benefits of LTSM in school revolves around those children who are either not as academically "talented" or have not shown "interest" in school. This method tends to stimulate these types [of] students into participating and eventually absorbing information that I believe they would not get from "normal" *show-me - tell-me* methods (lecture method). The importance of providing children with direct experiences with materials, objects, and phenomena is supported by experience and understanding of how learning takes place.

Most of the teachers have specified that they use materials and tools during science teaching in order to attract the attention of their students and increase the effectiveness and efficiency in science education teaching setting (Eksi, 2014). Additionally, teachers are concerned with the co-operation between school and family so they are trying to create connections between school science and the science in the community which the learners are familiar with. The next section discusses how teachers elicit learners' prior everyday knowledge during the teaching of the topic distillation.

2.6 Eliciting learners' prior everyday knowledge (PEK)

The study on learners' PEK in the teaching of science began in 1970s through watchful records of common errors made by students in solving physics-related problems (Roschelle, 1995). Connecting the science known by learners to their PEK is needed in teaching science to give the learners the science they can use in their everyday lives and build on their experiences (Stears, Malcolm & Kowlas, 2003).

The NCBE (2010) states that the teaching of science should be based on what learners already know and teachers should utilize learners' PEK for meaningful teaching to take place. This is important since most learners come to school with prior knowledge obtained from their local environment that should be acknowledged in the classroom (Oloruntegbe & Ikpe, 2011). In the same vein, it is advocated in the curriculum document that teachers should find a way of recognizing learners' prior knowledge (PK) about the concepts under study by recognising the science and misconceptions associated with the theoretical understanding (NCBE, 2010).

According to Roschelle (1995), to assist learners to make use of new experiences, teachers should comprehend how prior knowledge (PK) affects learning. For instance, Roschelle gave an example of a learner who did not know a certain topic like heat and temperature, no fast clarification can possibly resolve the contradiction between the hot desert and warm wool; it will take a learner some time for this understanding to be developed (Lewis, 1991; Roschelle, 1995). Roschelle added that PK determines what learners learn from practice and the learner simply could not understand knowledge about wool, because PK about heat makes received ideas senseless.

Similarly, Kasanda, Lubben, Gaoseb, Kandjeo-Marenga, Kapenda and Campbell (2005) argue that the Namibian curriculum based on learner-centred teaching has been fruitful in broadening learners' acquisition of skills and knowledge for understanding. They further state that when taking into consideration the learning effect of the use of daily contexts in science teaching, the differences in the methods of skills and knowledge building in everyday and scientific domains needs to be recognised. They added that the use of everyday experience in science classroom teaching has been promoted in Africa for the purpose of curriculum relevance, and because of this, the use of everyday context in science teaching should be used to build socio-cultural attainment, widening access and promoting learners' empowerment.

Stears, et al. (2003) state that in order to gain skills and knowledge, learners should become involved in the lesson presentations through the use of background knowledge of the learners' and scientific information. Ausubel (1968) acknowledged that if we are to offer prior knowledge a basic role in the teaching of science education, both pre-service and in-service teachers should be aware of the concept. Ausubel argued that the most vital factor that facilitates learning is what the learners already know; teachers should make instructional decisions based upon the learners' understanding and teach learners accordingly.

Windschitl (2002) acknowledges this in his review of research on constructivist teaching practices; the most intense challenges for teachers are not simply acquiring new skills but with building a personal sense of recognising learners' prior everyday knowledge as a starting point for teaching new instruction during their lesson progression. Moreover, incorporating PEK sometimes alters teaching in that is not immediately useful to the learners. In teaching science for understanding, PEK contains concept development that is more successful and produces a greater achievement of crucial outcomes such as problem solving, critical thinking, application of knowledge and teamwork (Stears, et al., 2003).

In his study, Roschelle (1995) argued that teachers have to study successful learning to avoid teaching Prior Knowledge (PK) in terms of dichotomies, and see PK as providing flexible building blocks, and for long-term transformations in the make-up and association of knowledge. For this to be effective, further study is required to find right ways to facilitate teachers' programmes to effectively build orderly science understanding through the use of PEK when teaching to enhance the concentration of learners as well as their cultural knowledge (Stears, et al., 2003).

Furthermore, Cook (2006) argues that PEK not only facilitates the theory of science learning it also has an influence on the perceptions and attention of the learners. He further argues that differences in the ways learners make meaning are based on what they already know (p.1075). Meyer (2004) adds that teaching requires teachers who appreciate what learners already know and come up with learning experiences that afford them opportunities to keep their knowledge to accommodate new skills and knowledge for better understanding of the topic. Proceeding, Meyer explains that experience will help to guide new teachers' practices, whether or not they observed teachers with expertise in implementing constructivist learning practices during their training (2004: 971-972).

I now discuss the indigenous knowledge I used to inform phase two in my study of understanding the teaching strategies used by Physical Science teachers during their teaching of the topic distillation.

2.7 Use of indigenous knowledge (IK) in science classrooms

Mosimege and Onwu (2004: 2) point out that IK is an all-inclusive knowledge that covers technologies and practices that have been and are still used by indigenous and local people for existence, survival and adaptation in a variety of environments. Since my study incorporated the traditional making of *Kashipembe*, it was hoped that the inclusion of IK in my study would help teachers to become creative and innovative during their classroom teaching. For instance, the local available materials used by community members to carry out distillation of *Kashipembe* are: *"Muyengo*" for "Condenser". These can be used by the teachers to make the topic more understandable to learners (see Section 5.3 figure (g)).

Therefore, teachers are encouraged to identify classroom activities by bringing concepts of IK that link with community science and school science. Relating to the statements above, Rennie (2011: 13) proposed the need for closing the gap between classroom and the community. Here, I used a community member to demonstrate the making of *Kashipembe* so that teachers could experience it and recognise that an indigenous practice could be used as a teaching strategy. Through IK the link between home experience and school science can be realised.

Furthermore, Ogunniyi and Ogawa (2008: 177) argued that the term IK has to do with the ideas of thought of the community of a certain geological location or socio-cultural environment. They maintain that this means that the knowledge has not been borrowed from others; rather it has become so assimilated into the new culture that it is difficult if not impossible to identify its original character.

Kibirige and Van Rooyen (2006) posit that IK is a legacy of knowledge and skills unique to a certain community. Furthermore, that indigenous culture entails wisdom that has been developed and passed on over generations. Similarly, IK is the knowledge, ideas and practices that are peculiar to a particular community and embody the community's identity and ways of surviving and maintaining the environment they find themselves in (Moahi, 2005). Van Wyk, (2002: 305) maintains that the increasingly multicultural and multilingual composition of South African classrooms, will mean that educators may have to address the complex challenges in terms of how they will give effect to science learning. Van Wyk also argues that the inflexible and dictatorial curricula of the past and present, with the policy frameworks for all learning fields makes teachers less creative and innovative.

Kibirige and Van Rooyen (2006) further point out that IK is not easily shared with members of another community due to the elements which disseminate it within different cultural communities. In the same vein, this imposes challenges to teachers in multicultural classrooms in South African/Namibian schools. Regrettably, IK was rejected due to the fact that it exists outside the classroom or scientific society and lacks some of the scientific proven elements (Shizha, 2007).

Shizha (2007) further states that problems encountered in effectively incorporating IK include teachers' attitudes, institutional demands as well as the subtle aims of education as perceived by educational administrators, teachers, students and parents. Therefore, incorporating IK is not always a successful teaching strategy; a teacher needs to understand how it can be applied during the teaching of distillation in the context of this study.

The next section focuses on theoretical frameworks which informed my study.

2.8 The theoretical frameworks

Since this study was about understanding the teaching strategies that grade 11 Physical Science teachers use when teaching the topic distillation, the following perspectives informed this study in its design and analysis, namely, Vygotsky's (1978) mediation of learning and social constructivism in conjunction with Shulman's (1986) pedagogical content knowledge (PCK).These theoretical frameworks are appropriate for my study as I hoped that the theories would afford me on some insights on theoretical learning from a social constructivism and PCK perspective. I now discuss each of these in detail below.

2.8.1 Mediation of learning

Overview of mediation of learning

The concept of mediation of learning is examined; focusing on the work of Vygotsky (1896-1934).Vygotsky posits that mediated learning is the action of social interaction between teacher and learner in the enrichment of the student's learning experience. Furthermore, mediation of learning is an important factor in learners' performance and success. Experimental studies were carried out to test each theorist's view of mediation of learning.

Presseisen and Kozulin (1992) stated that mediation of learning is the link between the teacher and learner which leads in part to the attainment of knowledge and skills in science. In their paper they discussed human mediation as being about involving another person in purposefully intervening in the learning process. Thus, they clarified that in Vygotsky's mediation process, a teacher mediates meaning by acting as a medium of symbolic mediation. The concept of mediated learning is seen as a big shift in the psychology that replaced the behaviourists' model with the cognitive concepts of human knowing and learning (Gardner, 1985).

Vygotsky (1978) arrived at the idea of the zone of proximal development (ZPD) which refers to the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance. In support of Vygotsky's ideas, Monteith (2007: 115) discussed ZPD as the cognitive changes that occur in the ZPD as teachers and learners share cultural tools, for example, language. He further states that this cultural mediated interaction produces developmental changes when it is internalised by the learners.

In addition, learners work within their ZPD when they are doing the task that they could not do alone but can do with the assistance of more knowledgeable peers or adults who help them to understand the concept better. Moreover, he maintain that working in the ZPD requires a good deal of guided participation; however, children do not acquire cultural knowledge passively from these interactions, nor is what they learn necessarily automatic or an accurate reflection of events. Thus, learners bring their own understandings to social interactions and construct meanings by integrating those understandings with their experiences in the learning context (ibid).

Goos (2004) explains the ZPD as a basic scaffold for explaining learning as increasing participation in a community of practice (Lave & Wenger, 1991) characterised by science inquiry. He therefore posits that teachers should be active participants and guide the learners to learn and solve problems independently.

In this study, I sought to investigate the teaching strategies that teachers use in scaffolding learners in the topic distillation. Goos (2004) goes on to use the term scaffolding as associated with the interactions whereby the teacher structured tasks to allow students to participate in collaborative activities. This is related to practical work discussed in Section 2.4 in this thesis.

Essentially, scaffolding is all about putting the task constantly on hold while waiting for the increase in the learner's involvement through graduated assistance (Hodson & Hodson, 1998). The Vygostkian theory gives teachers the central role of leading children and students to new levels of conceptual understanding by interacting and talking to them. His theory implies that, teaching comprises the activities which enable learners to participate effectively in the activities and learning is seen as enculturation via guided and modelled participation.

Monteith (2007) referred to scaffolding as the process in which children in challenging situations can develop their own thinking abilities through timely, appropriate guidance and support from teachers or peers. On the other hand, Woolfolk (1998) is of the idea that, Vygotsky's works entails that students should be given opportunities for co-operative learning and be encouraged to use language to organise their thinking. The next theoretical framework which informed my study was social constructivism which I discuss below.

2.8.2 Social constructivism

Given that in the design of the study I investigated teaching strategies specifically, I felt that social constructivism would be relevant in order to understand the teaching strategies that grade 11 Physical Science teachers use when teaching distillation.

McRobbie and Tobin (1997) posit that social constructivism entails knowing the value of society and individual aspects of learning and the development of understanding by writing and discussion of ideas with peers is an essential element in learning. Leedy and Ormrod (1989) affirm that students can build their knowledge as individuals when they are given the chance to discuss with others in their social group. This can be best reached through the use of learners' zone of proximal development (ZPD) (ibid).

Hodson and Hodson (1998: 36) state that educators should manage their effort in ZPD for every individual learner they are working with in their classrooms. To realize all these, teachers' pedagogical content knowledge (PCK) should be recognised and be integrated in the teaching of the topic distillation. I now discuss the teachers' PCK in the science classroom as the third theoretical framework of this study.

2.8.3 Pedagogical content knowledge (PCK)

Shulman's (1986) PCK has to do with the successful ways of presenting topics, the most powerful analogies, illustrations, examples, explanations, and demonstrations. In other words, it is the ways of representing and formulating the subject to make it understandable to others. He further claimed that teachers should have strong PCK to be the most excellent teachers. Therefore, science teachers should consider learners' experiences and difficulties in studying scientific content topics so that they can deliver content knowledge to their learners successfully (ibid).

In their Australian study, Loughran, Mulhall and Berry (2004: 371) found out the beginning of science PCK is thought to be the combination of a teacher's pedagogy and understanding of science content. This would influence their teaching in ways that would best engender learners' learning for understanding. They remarked that during the research project, their emphasis was on asking science teachers to discuss their topic specific PCK. As a result, they gave an example of why they teach particular content in a particular way which often led to explanations of exercises that were driven by educational reasons rather than those most closely connected with an understanding of the content. Thus, they maintain that PCK continues to be a seductive academic construct but not an easily identifiable aspect of practice; consequently, there is a lack of readily available concrete examples of PCK in the literature (p. 373).

According to Van Driel and Berry (2012: 27), the literature clearly shows that PCK is a complex process that is highly specific to the context, situation, and individual person. Their study implies that there is a need to come up with programs aimed at the improvement of teachers' PCK and should be organized in ways that are closely aligned to teachers' professional practice, including opportunities to perform certain creative teaching activities and materials to reflect individually on their previous work experiences. They state that research also shows that providing teachers with specific input can contribute to the development of their PCK.

One of the everyday jobs of the science teacher is to help learners to understand some of the pedagogical content knowledge (PCK) of science. Van Driel and Berry (2012: 26) argue that PCK includes "teachers' understanding of how students learn, or fail to learn, specific subject matter, the development of PCK is an important goal to focus on in professional development programs". Notably, PCK has to do with the demonstration and formulation of concepts, instructive techniques, and knowledge of what makes concepts difficult or easy to learn, knowledge of what learners know and theories of subject contents in science teaching (Koehler, 2011).

Koehler further explains that PCK can also involve facts of teaching style that include proper conceptual representations as these address learners' learning difficulties and misconceptions to foster meaningful understanding. He concluded that it includes PEK of what the students bring to the learning situation, knowledge that might be either facilitative or dysfunctional for the particular learning task at hand.

In line with this study, PCK was related to aspects which include: teachers, subject content, the science national curriculum, prior knowledge of learners and various strategies to be used by Physical Science teachers to identify learners' difficulties in order to improve learners' theoretical improvement and understanding of the topic distillation.

2.9 Concluding remarks

In this chapter I discussed the relevant literature that informed my study. In the discussion I presented what other scholars have researched and published about my topic distillation. The chapter also covered literature on the scientific background of the concept under study, use of teaching strategies, use of practical work, use of learning and teaching support materials (LTSMs), eliciting of learners' prior everyday knowledge (PEK) and use of indigenous knowledge (IK) to make sense of the concepts in the distillation topic. The theoretical frameworks that underpin my study, namely, mediation of learning and social constructivism as well as pedagogical content knowledge were also reviewed. In the next chapter I discuss the research methodology used in this study.

CHAPTER THREE: METHODOLOGY

> *Qualitative research gives voices to participants, and probes issues that lie beneath the surface of presenting behaviours and actions. Qualitative research collects information from a range of sources including amongst others, audio, film, documents and pictures, and it draws strongly on direct experience and meanings, and this may vary according to the style of qualitative research undertaken (Cohen, Manion & Morrison, 2011: 219).*

3.1 Introduction

The main goal of this study was to understand the teaching strategies that grade 11 Physical Science teachers use when teaching the topic distillation. This chapter thus describes the methodological framework that guided the research process. To this end, I describe and discuss the reasons for selecting an interpretive paradigm and qualitative case-study approach to address my main research question and sub-questions.

Furthermore, I discuss the data gathering techniques I used in the study, the sampling of the participants and how the data were analyzed. This chapter also discusses issues regarding ethical considerations, validity and trustworthiness together with the limitations of the study. I complete this chapter with some concluding remarks.

3.2 Research paradigm

Research paradigms have to do with the way people sense, look at things to study and know them so that they can make conclusion or recommendations based on their findings. In addition to this,

> A paradigm is a way of looking at, or researching phenomena, a world view, a view of what counted as accepted or correct scientific knowledge, a shared believe system or set of principles, the identity of the research community, a way of pursuing knowledge, consensus on what problems are to be investigated and how to investigate them, typical solution to problems, and an understanding that is more acceptable than its rivals. (Cohen, et al., 2011: 5)

Thus, my research was underpinned by an interpretive paradigm. I have chosen an interpretive paradigm in order to understand how grade 11 Physical Science teachers mediate learning of the topic distillation.

3.2.1 Interpretive research paradigm

According to Cohen, et al. (2011: 18), an interpretive paradigm starts with individuals and sets out their interpretation of the world around them. An interpretive paradigm provides meanings and rationale which have to do with human actions and depends on the watching, clarification and the interpretations of people's actions toward a specific phenomenon. To this end, Cohen, et al. (2010: 26) voiced that the aim of interpretive research is to offer more explanation of the event, or where necessary, to develop some explanation for it. Moreover, the interpretive paradigm provides an opportunity of understanding the situation of the problem under study through interaction.

Through using the interpretive paradigm, I worked directly with my participants (teachers) and gained insight into how they mediate learning of the topic on distillation in the classroom. Within the interpretive paradigm, a case study was adopted and I discuss this below.

3.2.2 Case study

According to Merriam (2009), a case study is an in-depth description and analysis of a bounded structure. Furthermore, a case study is an intensive description and analysis of a phenomenon or social unit such as an individual or group (Merriam, 2002). Moreover, in case studies researchers tend to specifically concentrate on a particular case; it might be due to the case under study with the understanding of informing the current educational practices (Leedy & Ormrod, 2010). In the context of my study, the case was two Grade 11 Physical Science teachers teaching the topic distillation and my unit of analysis was meaning making of the topic distillation. According to Maree (2012: 75),

> From an interpretivist perspective, a case study is linked to the ways researchers strive towards a holistic understanding of how participants relate and interact with each other in a specific situation and how they make meaning of a phenomenon under study. Case studies offers a multi-purpose analysis in which a researcher considers not only the voice and perspectives of one or two participants in a situation, but also the views of other relevant groups of actors and interaction between them. It opens the

> possibilities of giving a voice to the powerless and voiceless, like children or marginalised groups. This is essential for a researcher to come to a deeper understanding of the dynamics of the situation, and this aspect is a salient feature of many qualitative case studies.

To Jack (2008), a qualitative case study is an approach to research that facilitates exploration within its context using a variety of data gathering techniques. Creswell (2003) posits that qualitative case study research provides a way for the researcher to work together with the research participants. Notwithstanding, qualitative case study is all about the approach which strives to understand the problem in a real life setting where the researcher does not just try to manipulate the topic of concern (Maree, 2012: 78-79).

A case study approach was appropriate in this study as it enabled me to focus on my topic under study hoping to understand the current teaching strategies used by teachers to teach distillation. Through a case study, I was able to generate thick descriptions of my participants' views and experiences on teaching strategies they use when teaching distillation.

In the context of this study, the qualitative case study method was used to work closely with my research participants (two teachers) to explore what teaching strategies they use to teach the topic on distillation. Additionally, I also looked at a cultural practice of making a traditional alcoholic beverage called *Kashipembe* with a view to enhancing the teaching of the topic distillation.

3.3 Research goal and questions

Research goal

The main goal of this study was to understanding how grade 11 Physical Science teachers mediate learning of the topic distillation in the Kavango Region. To achieve this goal, the following main research question and sub-questions guided the study:

Main research question

What teaching strategies do grade 11 Physical Science teachers use when teaching the topic distillation?

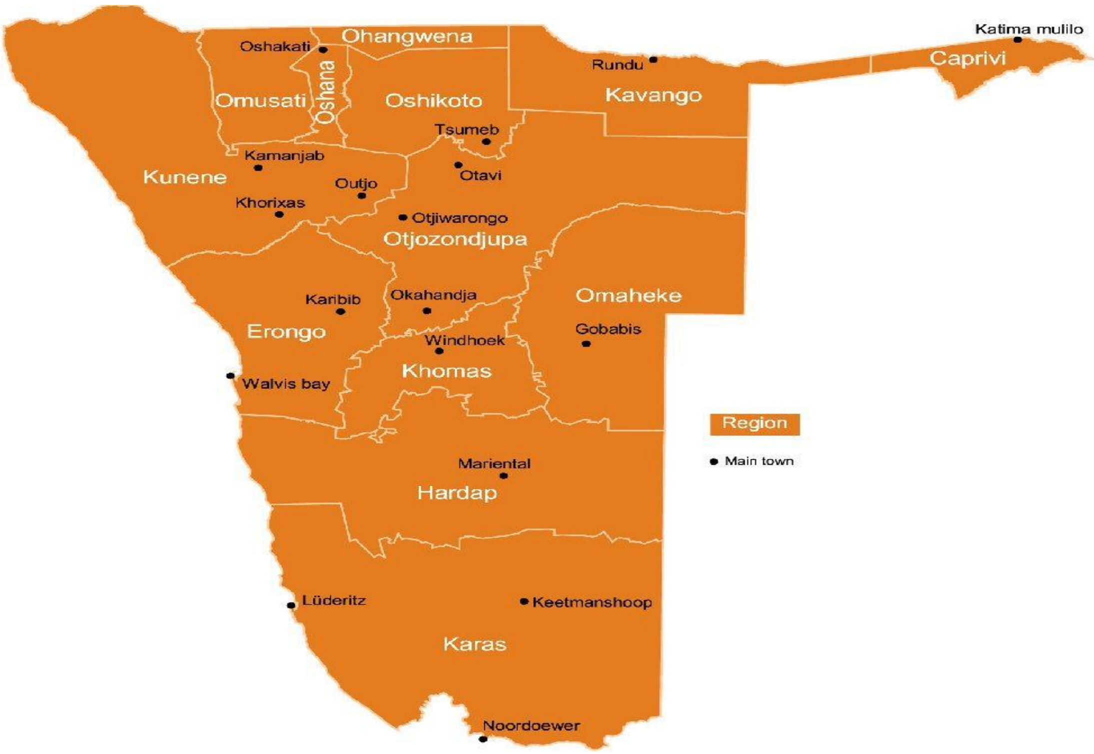
Sub-questions:

- In what ways do grade 11 Physical Science teachers help learners make sense of the concepts on distillation?
- What enables or constrain learners from making sense of concepts on distillation?
- In what ways can grade 11 Physical Science teachers improve their teaching strategies when teaching the topic distillation?

3.4 Research site

The research was carried out at two sites in the Kavango (East & West) Regions in Namibia (see figures 3.4 (a), (b) and (c) maps of Kavango West and East of Namibia and map of Namibia respectively. Unfortunately, the two maps of Kavango East and West Regions are still in black and white as these regions are relatively new.

Figure 3.4: Showing all the Regions of Namibia



Phase one of my research was scheduled to take place at two government schools. I decided to conduct my research where I was working to avoid the expense and inconvenience that might occur when using other schools.

I used pseudonyms for the two schools; I asked the two teachers at both schools to suggest their pseudonyms; Yebo and Tushetekenu Secondary schools were proposed. Both schools are secondary schools with grades 8-12 in the Ncuncuni and Rundu circuit but in different regions (Kavango East and Kavango West Regions). However, currently both schools fall under one director of education in the north-eastern part of Namibia. We the Kavango people are not aware of what the two names mean in our language.

In addition, for Phase Two a practical demonstration of *Kashipembe* was done at the community member's house which was within my reach. Due to administration issues and organisation, the community member did the distillation process at her house to give her all the freedom to conduct the process the way she knows how. This was also to avoid any inconvenience which might arise in the transportations of materials used from her house to school. The practical demonstration was conducted in Rumanyo; thereafter I translated it into English.

Most learners at the two schools speak either Rumanyo or Rukwangali as their home language and English as their second language. Therefore, the medium of instruction for the two schools is English as a Second Language, referred to as the language of learning and teaching (LoLT).

In this study, I used convenience and purposive sampling. Convenience sampling has to do with choosing the nearby individuals to serve as respondents and continuing that process until the required sample size has been obtained or those who happen to be available and accessible at the time (Cohen, et al., 2011: 155-156).

Purposive sampling is a procedure in which the researchers choose whoever is believed to be representative of a given population (Springer, 2010). Thus, purposive sampling was used to decide on which grades and teachers should be part of this study. The grade I worked with was the Grade 11 Physical Science class at both selected secondary schools. In both schools I worked closely with only one of the grade 11 science classes.

3.5 Participants

The two teachers who were my participants were asked to choose their own names and they came up with the names: Mr. Strong (pseudonym) who is teaching at Tushetekenu Secondary School (pseudonym) specialising in Physical Science and Biology and at the time of this study he had six years teaching experience in Physical Science grades 8-12. Mr. Gaps (pseudonym) teaching at Yebo Secondary School and specialising in Physical Science and Mathematics had 3 years teaching experience of Physical Science grades 8-12. I chose these teachers because they were within my reach at the two secondary schools mentioned above.

Furthermore, I involved a community member who demonstrated the making of *Kashipembe* which involved a distillation process. The community member was selected with the help of the learners who stay in the community. The selection was done because she was known in the community for making *Kashipembe* and also she was within the reach of the schools. After negotiating with her, she agreed to be one of my participants in this research study. She demonstrated the process of making *Kashipembe* at her home.

My role as a researcher was facilitating the research process and observing while the two teachers were teaching the topic on distillation. I also asked permission from all the participants, building rapport with them and involving them to interact fully in the research study. I also videotaped, transcribed and analysed the data, which I then interpreted and presented in different ways.

3.6 Data gathering techniques

In this study I used the following data gathering techniques, namely:

- Document analysis;
- Observations;
- Interviews (semi-structured and stimulated recall interviews); and
- Brainstorming and discussions.

Data gathering techniques were used in two phases. Phase One was aimed at answering research sub-questions 1 and 2, while Phase Two aimed at answering research sub-question 3.

Phase 1

This phase aimed at answering research sub-questions 1 and 2 which are:

- *In what ways do grade 11 Physical Science teachers help learners make sense of concepts when teaching the topic distillation?*
- *What factors enable or constrain learners from making sense of the concepts on the topic distillation?*

I now discuss the data gathering techniques I used in Phase One below.

3.6.1 Document analysis

The first research technique that I used in this study was document analysis. Document analysis refers to a process of reading any historical documents which need to be assessed in order to find the required information. Yin (2003) points out that document analysis is more likely to be relevant to all case studies because in most cases it takes a variety of compositions and tends to be a primary data gathering tool.

The documents analysed in this study included; Curriculum documents, five grade 11 Physical Science textbooks, teachers' lesson plans, learners' workbooks and a test. However, Curriculum documents such as the syllabus and Examiners' Reports were used to contextualise my study.

Document analysis was helpful in this study in verifying the correct spelling and titles or names of something that might have been mentioned in an interview, and provided specific detail to correspond information to other sources (Yin, 2009: 103). I was able to analyse teachers' lesson plans on how they prepared before teaching the topic on distillation. This was necessary for me to understand how they go about planning their teaching in order for the learners to make sense of the topic distillation.

Textbooks used by the two teachers and learners' workbooks; syllabus and policy documents yielded more information regarding support and teaching of the topic on distillation. A test on distillation was written after the lesson presentations and this test was set and marked by the participating teachers. Thereafter, I discussed and reflected on the test with each teacher. I now discuss observation as one of the data gathering tool used in my study.

3.6.2 Observations and Field Notes

Observations offer opportunities to the researcher to gather 'live' data from naturally occurring social situations (Cohen, et al., 2011: 456). Observation in my study focused on the six lessons presented in the classroom and the community member's practical demonstration on making *Kashipembe* at her home. I observed two Grade11 Physical Science teachers teaching the topic on distillation in their school contexts. I had planned to observe at least four lessons per teacher on distillation but due to the syllabus and its basic competencies demand, I only managed to observe three lessons per teacher giving a total of six lessons observed instead of the intended eight lessons. The importance of using PCK (see Section 2.8) which I used as one of the theoretical frameworks in this study was one of the main aims of the observation.

During the lesson observations, I tasked a colleague who is also a teacher at another school to videotape the lessons so that I was able to take some field notes and concentrate on the observation schedule which I planned to use. Unluckily, he did not turn up for videotaping the lessons so I had to videotape all these lessons myself using my laptop, which made me not to use an observation schedule. After presenting the lessons the two Physical Science teachers were then interviewed to get further data on the teaching strategies that they used when they taught the topic on distillation. Creswell (2012) argues that field notes are text (or words) recorded by the researcher during an observation in a qualitative study. However, I could not do this as planned for the reason given above.

Another observation I did was when a community member did a practical demonstration on making *Kashipembe* which is a traditional beer to illustrate the concept of distillation. All the discussions, questions and answers with learners and the community member at the site of making *Kashipembe* were videotaped. The discussions were in Rumanyo, just to make the participant (community member) feel relaxed so that she could give all the necessary information. Sadly, though, the battery of my laptop was flat and I had to use my cell phone to take photographs of some of the apparatus used during the demonstration process of making *Kashipembe*.

3.6.3 Interviews

According to Maree (2012), interviews are the type of communication where the interviewee responds to the questions posed by the interviewer with the intention of collecting the intended data or information. Interviews enable participants (interviewers or interviewees) to discuss their interpretations of the world in which they live in and express how they regard situations from one point of view. Interviews also helped me to get direct live responses about complex and deep issues (Cohen, et al., 2011: 409). In this study, I used semi-structured and stimulated recall interviews and I discuss each of these below.

3.6.3.1 Semi-structured interviews

Johnson and Christensen (2004) explain that semi-structured interviews allow a researcher to decide and select participants. Furthermore, semi-structured interviews are the most widely used interviewing format for qualitative research and can occur either with an individual or in groups (ibid). So, I conducted individual interviews with two Grade 11 physical science teachers from the two selected schools. The first interview was a pre-interview and the second was a post-interview. The pre-interview was conducted with a view to hearing about the general teaching strategies used by them when teaching at their respective schools. And the post-interview was intended to get more information about the teaching strategies the teachers used when teaching the topic distillation. All the interviews with the two teachers were conducted during break time when they were free. The interviews were all about 20-30 minutes long (see Appendices H (i)-(iv).

The interview with the community member was conducted in order to gather more data and hear her views and experience on how she made *Kashipembe* (see Appendix D (iv)) interview schedule). Follow-up questions were asked to get clarity on some of the points that were not clear. The interview with the community member was conducted at her house in the afternoon after school and it took about 30 minutes.

The semi-structured interview was important in my study as it was used to get in-depth data on the teaching strategies that the Grade 11 Physical Science use to teach the topic on distillation as well as the making of *Kashipembe* in the community. During the semi-structured interviews, I followed the standard questions of my research to get clarification and further investigate my participants reasoning on the topic distillation (Leedy & Ormrod, 2010: 188).

3.6.3.2 Stimulated recall interviews

A Stimulated Recall Interview (SRI) is an "introspection procedure in which (normally) videotaped passages of behaviour is replayed to individuals to stimulate recall of their concurrent cognitive activity" (Lyle, 2003: 861). The main idea of using an SRI is to explore the practice used to generate the subject's thinking during the period being replayed.

SRI was performed with my participating teachers while watching the videotaped lessons. That is, after the observation process I went back to my participants - both teachers and community member to watch the recorded videos with them. I used member checking by giving the transcripts back to my participants. They watched the videos while holding the transcripts to see where I had recorded incorrect information and made the changes. Herein lies the importance of validation of data (see Section 3.8). Likewise, the stimulated recall interviews themselves were a validation process. They also informed my Phase Two in this study which I discuss below.

Phase 2

3.6.4 Development of two model lessons on distillation

This phase aimed at answering my third research sub-question which is: *In what ways can Grade 11 Physical Science teachers improve their teaching strategies when teaching the topic distillation?*

One model lesson on the distillation process was developed together with my participating teachers. This was done with a view to enhancing the teaching and learning of the topic on distillation. But initially the teachers were unable to come together for the model lesson development citing the work load at their schools as their reason.

Together with the teachers we thus came up with some suggestions on how science teachers could use teaching strategies when teaching the topic distillation in rural areas where there is availability of materials to carry out distillation. Also, the integration of contextual scientific knowledge in the classroom combined with community knowledge of making *Kashipembe* by a community member served as a sense making exercise for the topic distillation. Through co-developing this lesson and demonstration of making *Kashipembe* co-learning amongst ourselves was facilitated.

3.6.5 Brainstorming and discussions

Brainstorming and discussions were used to find out about what learners already know about the preparation and making of *Kashipembe*. All the Grade 11 learners were involved in the discussions on making *Kashipembe* in different communities. Learners gave their input on how *Kashipembe* is made traditionally in different communities in Kavango East and West regions. The brainstorming and discussions were transcribed and these were videotaped. The learners did not write on the chalkboard in order to save time. I compiled guiding questions which I used during the brainstorming session with the learners (see Appendix D (iii) for guiding questions).

3.6.6 Pilot study

A pilot study of my interview questions with the two Grade 11 Physical Science teachers was conducted at the beginning of the academic year 2014 with one teacher who was my classmate in a Master of Science Education class. The pilot helped me to determine if the chosen techniques were likely to help me in gathering data and answer my research questions and see where I could make improvements.

Table 1: Showing the tools, methods and the purpose for data to be gathered

Stage	**Method used to gather data**	**Data to be gathered**	**Purpose of gathering the data**
Phase 1			
Stage 1	Document analysis. Documents analysed: Curriculum documents NSSCO Physical Science grade 11-12	What curriculum documents say the topic distillation.	To find teaching styles specified on my topic distillation.

	syllabus Textbooks, Lesson plans for teachers and Learners' workbooks Examiners' report for external examination of grade 12	The content covered on the topic distillation and Practical work related to distillation topic. Content in prescribed textbook for Physical Science grade 11-12 on the topic distillation. Lesson plans of teachers, learners' workbooks To get comments made on distillation questions	To find out information about the content covered on topic of distillation under suggested practical activities in the syllabus. To see how much support teachers get from textbooks in the teaching of the topic distillation. To gain insight into how teachers scaffold learners in the mediation of learning on the topic of distillation. To obtain information about problematic areas on topic distillation during examinations. To know the comments made about the topic distillation in external examination.
2	Observation of lessons and field notes	The teaching strategies that teachers used.	To identify and capture all live data in teaching practice inside the classroom, teachers' PCK and how teachers elicited learners' PEK when teaching Physical Science.
3	Interviews: Semi-structured Stimulated Recall	Teachers' teaching strategies on distillation. To clarify any misreading in the specified stages. This also informed my Phase Two.	To seek clarifications on the teaching strategies of teachers in scaffolding learners when teaching distillation and the eliciting of PEK by teachers. To validate my data and to locate my insights into the participants' views of understanding. Baseline data for the planning of the lessons in Phase Two
PHASE 2			
4	Brainstorming and discussion	Explanations on how *Kashipembe* is made in general.	To obtain learners everyday knowledge on making *Kashipembe*.
5	Development of the two lessons together with the two teachers.	To enhance and improve the teaching of distillation after reflection on previous lessons on topic on distillation	To answer my third research sub-question and this helped me to see how the teaching of distillation can be improved.

3.7 Data analysis

Data analysis refers to the ways researchers make meanings of the data they have gathered in their respective topics. Cohen, et al. (2011) state that data analysis in qualitative research has to do with organising, explaining, and making meaning about the data obtained from the participants and categorising them into themes. They further maintain that the method of data analysis needs to be looked at and be selected carefully to fit the phenomenon under study given that data analysis is flexible depending on the concepts under study. I used qualitative data analysis to ensure that my research question was considered and answered.

An inductive analysis was used during my data analysis process. Thomas (n.d.) states that the purpose of using an inductive approach is to reduce raw data into a brief note format and to establish clear links between the research questions and the summary findings derived from the raw data. Schudel (2012) states that inductive data analysis has to do with categories which have been derived from the data gathered in a study. Schudel explained that to do this one has to label the data sources, read text relevant to the research questions, use the list of emerging categories and organise data that fits into each category.

Inductive analysis deals with identifying different realities about a phenomenon which are potentially present in the study (Maree, 2012). The interviews with the two Grade 11 Physical Science teachers and community member were transcribed and translated into English. Furthermore, the gathered data and the discussions with the two teachers and community member were analysed through coding.

Creswell (2012) defines coding as the method of dividing passage and categories to form explanations and broad themes. Therefore, I used codes for the following themes: use of prior teaching strategies, use of practical work, use of learning and teaching support materials (LTSM), use of prior everyday knowledge (PEK) with this I am referring to previously learned contents in Physical Science, use of indigenous knowledge (IK) is referring to the knowledge learners have from their community and sense making of the topic distillation which was informed by mediation of learning, social constructivism and pedagogical content knowledge (PCK) of the teacher. These themes are discussed and interpreted in Chapter 6.

The mediation of learning, social constructivism and PCK in this study helped me to understand how the teachers teach the lessons, specifically how they delivered the lesson content to learners. Also, their interactions with their learners, the integration of learners' everyday knowledge and connections to community practice to make sense of the concepts on the topic distillation were illuminated through these theoretical frameworks. These were analysed by describing and explaining information obtained from interviews and observations on presented lessons on distillation.

3.8 Validity

Validity is an important key to effective research and it is a requirement in qualitative research (Cohen, et al., 2011: 179). In addition, Creswell (2012) argues that validity is the development of sound evidence to demonstrate that the analysis about concepts is assumed to match its use. Therefore, the research methods I selected in this study were used to ensure validity in the whole research process by using data triangulation. Cohen, et al. (2011) explains that triangulation is the use of two or more methods of data collection in the study that serves a certain purpose in the study. Thus, in this study I used document analysis, observations, interviews (semi-structured and stimulated recall interviews) and brainstorming and discussion.

To validate my data, I also used member checking by giving the transcripts back to the research participants so that they could check if what they said was clearly presented or not. However, when my participants were given the transcripts for member checking, Mr. Strong pointed out that some of the things mentioned during the lesson were not intentionally done, for example, like use of “ya” and “guys” (see Appendix H). In contrast, Mr. Gaps only read some transcripts as he did not have enough time, and confirmed that what I wrote was correct. Maree (2012: 86) states that member checking is a strategy used to verify researchers understanding of what is observed with those observed (participant). Thus, in addition to member checking, I also used stimulated recall interviews as discussed above (see Section 3.6.3.2).

3.9 Ethical issues or considerations

Creswell (2012: 620) explains that ethical issues in qualitative research are issues such as informing participants of the purpose of the study, refraining from deceptive practices, sharing information with participants, being respectful of research site, using ethical interview practices, maintaining confidentiality, and collaborating with participants. In this study, I sought permission from the Circuit Inspector, from the two secondary schools

(Principal/management) and from the two Grade 11 Physical Science teachers. The permission was granted as requested.

Even though the focus of my study was on the two Physical Science teachers, permission was also obtained from the parents of the learners who were participating in this study. I did this by sending out letters, which were written in Rumanyo and English, to the parents of the learners in the two Grade 11 classes (see AppendicesD (ii)).The parents gave me their permission and for the learners in the hostel at Mr. Strong's school permission was granted by the hostel father or superintendent. However, it would have been helpful if I could have approached the parents myself. I say this as some learners might have ticked the permission box themselves.

All the participants were informed about the purpose of the research as well as its potential value in the context of improving understanding of science concepts in Chemistry, in particular, in the topic on distillation. Confidentiality and anonymity were guaranteed and the participants were free to withdraw if they wanted to do so at any time from the research. The participants were also given an opportunity to watch the videotaped lessons and check interview transcripts. Thereafter, they discussed the interpretations which they felt did not accurately reflect their views and practices in the transcriptions with me.

In my Phase Two I told my learners not to try and taste *Kashipem*be as it is alcoholic. Learners where also told to be stay away from fire during the practical demonstration. Lastly, co-development of the model lessons together with the two teachers helped to recognise the teachers' agency in the construction of knowledge in relation to the topic on distillation.

3.10 Limitations of the study

Being a case study of only two schools in Namibia, the results of this study cannot be generalised. However, the study presents some insights on the teaching strategies that grade 11 Physical Science teachers use to teach the topic on distillation. Herein lies the importance of pedagogical content knowledge.

Some other limitations included the following:

- The battery of the laptop went flat so I substituted it by using a cell phone;
- Studying for a Master of Science degree was seen as threatening to the science teachers who might have withheld information;
- I found that learners were excited when they noticed that I was taking a video which disrupted the lesson for some time;
- The intended eight lesson observations did not materialize and I was worried that I might not get enough data;
- The teacher who was supposed to take all my videos did not turn up which was frustrating. I substituted the camera with my laptop and this compromised the field notes I wanted to take;
- Reluctance of teachers to come together for two model lessons also gave me a headache as I thought this would affect the success of the lesson development; even though we negotiated with both teachers; and
- My translations of Rumanyo to English might have left out some invaluable information.

3.11 Concluding remarks

In this chapter I described the research design which I used to generate insights that explain my study. I also discussed the data gathering techniques used to generate data in order to answer my research questions. Brainstorming was used to explore the making of *Kashipembe*. I also discussed the ethical considerations, validity and limitations of the study. Thereafter, I explained the method of data analysis and how data were interpreted to draw conclusions from the findings.

In the next chapter I present the data that I gathered from my Phase One, that is, document analysis, observations and interviews.

CHAPTER FOUR: DATA PRESENTATION: PHASE ONE

> *Holistic approaches to qualitative data presentation will want to catch the wholeness of individuals and groups, and this may lead to a more narrative, almost case study or story style of reporting with issues emerging as they arise during the narrative (Cohen, Manion & Morrison, 2011: 552).*

4.1 Introduction

In this chapter, I present data obtained from my Phase One. The data is derived from the document analysis, observations on three presented lessons, interviews and the test. These data sets were supplemented through the viewing of recorded videos. As alluded to in the epigraph above, the data from interviews and lesson observation are mostly in the respondents' own words. The chapter ends with concluding remarks on the alignment of the data to my research question. I now present my Phase One data as follows:

Phase One

This phase aims at answering research sub-questions 1 and 2 which are:

- *In what ways do grade 11 Physical Science teachers help learners make sense of concepts when teaching the topic on distillation?*
- *What factors enable or constrain learners from making sense of the concepts on the topic on distillation?*

The presented data were obtained from the following data gathering techniques:

- Data from document analysis;
- Data from interviews;
- Data from lesson presentations on distillation and scientific concepts emerged; and
- Data from the two tests.

I now present data from each technique below.

4.2 Document analysis

First and foremost, I used document analysis as the first data gathering technique to collect data. I looked at both strategies used by the teachers and the factors which may enable of constrain learners from understanding the topic distillation as outlined in these documents. Therefore, the analysed documents included: The Namibian syllabus for Physical Science grade 11, Examiners report, Namibian Physical Science Subject Policy Guide Grades 8-12, Namibian National Curriculum of Education and grade 11 Physical Science textbooks, teachers' lesson plans and learners' workbooks.

4.2.1 Textbook 1: *GCSE CHEMISTRY* (Contents on distillation) Tushetekenu Secondary School (pseudonym) and Yebo Secondary School (pseudonym)

This textbook is used only by Mr. Strong at Tushetekenu Secondary School. In this textbook no prior everyday knowledge (PEK) of learners is elicited under the chapter of distillation. However, the textbook outlines the main content of the topic on both simple and fractional distillation and it is in line with the latest school syllabus of Physical Science in Namibia. The content was educative on both simple distillation and fractional distillation. Examples of labelled figures of both processes were indicated (see Appendices E (i) & (ii)). The figures were useful in helping learners understand the topic.

Nevertheless, questions asked at the end of the topic in this textbook were at the level of grade 11/12, which is in line with the content of the book. Furthermore, the questions in these textbooks were clear and could be easily understood by the learners. The questions included practical questions where learners are required to follow steps and instructions to answer some of the questions. The language used in the textbooks is up to standard. A glossary was given at the back of the topic as a checklist. The illustrations on distillation in the textbook are colourful and were gender sensitive, with pictures of males and females (see Appendix E. (iii)).

4.2.2 Textbooks 2 & 3: Physical Science for Southern Africa and Chemistry Made Clear

The *Physical Science for Southern Africa* textbook is used only by Mr. Gaps at Yebo Secondary School. In this textbook prior knowledge of learners was elicited under the chapter of distillation, where they gave an example of preparing a traditional brew made from fermenting sorghum seeds in some rural areas. The textbook gives the main content of the topic on both simple and fractional distillation and it is in line with the latest school syllabus of Physical Science in Namibia. Also, the content written down was educative on both simple distillation and fraction distillation. Examples of labelled figures on both processes were indicated as in the GCSE Chemistry book (see Appendix E (i) and (ii)).

EXCERCISE3 2. In some rural areas traditional brew is made by fermenting sorghum seeds. The ground seeds are removed from the beer before it is sold to customers. This is done by squeezing the mixture in a small sack made from a woven grass. a) State which method of separating mixtures this process is similar to. b) State which laboratory material the sack is similar to.

Table 4.2.2 ***Dube et al' (2008: 266), Physical Science for Southern Africa***

The steps to follow when carrying out practicals for teachers and learners is only outlined in the Chemistry Made Clear textbook which is used by Mr. Strong at Tushetekenu Secondary School. Questions asked at the end of the topic in these textbooks were at the level of grade 11/12 which is in line with the content of the book. Furthermore, the questions in these textbooks were clear and could be easily understood by the learners. The questions included practical questions where learners are required to follow steps and instructions to answer some of the questions. The language used in the textbooks is up to standard. No glossary was given at the back of the textbook. The illustrations on distillation in the textbook are not colourful and did not address gender stereotypes, no picture of males and female are shown in these textbook.

4.2.3 Textbooks 4 & 5: Chemistry counts and Physical Science. NAMCOL, Module 3

These textbooks are used by both teachers at the two secondary schools. In these textbooks the chapter does not cater for eliciting learners' prior knowledge (PEK) when learning the topic on distillation (see Section 2.6). The textbooks deal directly with the content of both simple and fractional distillation. However, the content concentrated on simple distillation and fractional distillation. In the Chemistry counts book it only gave an example of simple distillation and fractional distillation on separation of petrol from crude oil set-up diagrammatically while the NAMCOL Module 3 did provide examples of labelled figures on both processes (see Appendices F (i), (ii) and (iii)) extracted from NAMCOL textbook.

The steps or instructions to be carried out by teachers and learners when conducting experiments were not outlined in the two textbooks. Rather, the textbooks included results and conclusions of the processes. e.g. the boiling point of water is about 100^0C and boiling point of alcohol is about 78^0C. Yet, questions asked at the end of the topic in both textbooks were at the level of grade 11/12 which is in line with the content of the book. The questions in this textbook were clear and could be easily understood by the learners.

Questions

1. Explain the following :
   Evaporation; condensation; distillation; distillate
2. What is the difference between simple distillation and fractional distillation?
3. Two important processes that involve distillation are the manufacture of brandy and whisky. Brandy is made by distilling wine; whisky is made by distilling beer. Both brandy and whisky contain alcohol (boiling point, 78^0C) and water (boiling point, 100 ^{0}C).
   (a) Which liquid boils at a lower temperature, alcohol or water?
   (b) Which of these two liquids (alcohol and water) evaporates more quickly, give a reason to support your choice?
   (c) If beer is distilled, will the distillate contain a larger or smaller percentage of alcohol; give a reason for your answer?
   (d) Why is whisky more alcoholic than beer?

Table 4.2.3. Hill (1986: 19), Chemistry counts

The language used in the book is easy to read and can be understood by both learners and teachers. No glossary was given at the back of the two textbooks to explain some terms and concepts. Instead, Physical Science NAMCOL Module 3 provides a summary at the end of the topic (see Appendix F (iv)). The illustrations in these books are not colourful and do not favour any gender stereotypes, no picture of a male or female was shown in these textbook.

4.2.4 Learners' workbooks

4.2.4.1 Learners' workbooks at Tushetekenu Secondary School (pseudonym)

In Tushetekenu Secondary School learners are given two exercise books each. A big exercise book is used for notes and small exercise book is used for activities for Physical Science. When I went through their note books there is an indication that the teacher had covered most of the work as they had a lot of information according to requirements of the basic competencies. However, the handwriting of some learners is a little poor. The activity books showed that the teacher did not give sufficient exercises on the covered topic for learners to work on the topics covered. I mention this because the contents (summary) section given in the note books is greater than the activities section. This supported the finding that learners must be given practical activities or demonstrations that are considered essential, and which all learners should be exposed to, as preparation for the Applied Practical Skills examination (assessed by the National Examination at the end of Grade 12). These are included at the end of each topic in the Namibia Physical Science Subject policy (2009: 3).

This also raised a concern, because if the learners are not given many activities and are not exposed to questions they are unlikely to perform well in that particular area. Despite that, the given activities were marked by the teacher with a red pen; cross for wrong answer and a tick for correct answer. The learners wrote corrections for what they got wrong. The questions asked varied from easy to more challenging. In other words the teacher followed the syllabus requirement on assessment objectives. The teacher asked questions of *knowledge with understanding, handling information, application and* solving problems and practical (experimental and investigative) skills and abilities.

4.2.4.2 Learners' workbooks at Yebo Secondary School (pseudonym)

The two schools were I conducted my study were both government schools. In Yebo Secondary School the learners were also give exercise books just like at Tushetekenu Secondary School. A big exercise book is used for notes and a small exercise book is used for activities for Physical Science. The problem of handwriting was again an issue at both schools. It seems as if the teachers are not encouraging learner to write neatly. Again the activities given to the learners were insufficient when compared with the summary they had written down in their note books. Since, these schools are found in the neighbouring circuits maybe they planned collectively for the circuit-based activities. After analysing the learners' books at Yebo Secondary School I found that the activities carried out at both schools are more or less the same on the topic of experimental techniques which included distillation.

4.2.5 Teachers' lesson planning

The lesson plans were looked at for both teachers to see how often they prepare in advance to ensure that teaching and learning prevails in the classroom. I also looked at teachers' lesson plans to see how they divide the contents on distillation to deliver the information to learners in the given time or period.

The lesson plans of both Mr. Gaps and Mr. Strong presented all the aspects of a lesson plan according to national standard. These include indication of name of the teacher, date, grade, duration, period, subject, theme, topic, objectives, basic competencies, presentation, conclusion, assessment, reflections and signatories. However, Mr. Strong's lesson plan did not contain the topic contents to be taught to the learners. Instead it showed the guidelines on what the teacher and learners should do during the specific period (see Appendix G (vi)). While the lesson plans for Mr. Gaps clearly contained the necessary contents on distillation to be presented to the learners during the period (see Appendix G (vii)). Both teachers do daily lesson preparation in advance before they present their lessons. Their preparations are in accordance with the latest Namibian syllabus of Physical Science (2010) as developed by the National Institute for Educational Development (NIED) in collaboration with the University of Cambridge international examinations. Both teachers' lesson plans adhere to the requirement of National Standards and Performance Indicators for schools in Namibia.
The lesson plans for both teachers included the type of homework or assessment to be done. However, Mr. Gaps gave one group activity and Mr. Gaps also gave one quiz which was done individually. Where they did not give activities, they wrote the following on the assessment part on the lesson plan: Mr. Gaps; "*learners will be asked individually to mention the apparatus used during simple distillation process"*. Mr. Strong wrote as: "*ask learners to study steps and be able to explain it to the class the next day"*.

4.3 Interview with the two Physical Science teachers

The next data gathering technique I used was interviews. The interviews were conducted before commencing with the main research project. The purpose of the interviews was to understand how Grade 11 Physical Science teachers mediate the topic distillation at their schools. These interviews took place on the 14th May 2014, at 10:00 at Tushetekenu Secondary School with Mr. Strong and 30th June 2014, at 10:00 at Yebo Secondary School with Mr. Gaps. Mr. Strong has taught Physical Science grade 11 for four years at Tushetekenu Secondary School while Mr. Gaps has taught Physical Science for five year at Yebo Secondary School. I came up with five guiding interview questions for this interview (see appendix D, (i) & (ii)). Additionally, I also asked some follow up questions to probe further.

4.3.1 Pre-Interview with Mr. Strong

The interview with this teacher was in the form of semi-structured interview. The first question I asked him was about the introduction of the lesson on the topic distillation. The following are his responses to the question including the follow up questions responses.

> *"I introduce them according to basic competencies (these are the skills which learners should be able to know after the lesson or topic). Actually when it comes to basic competencies, I actually explain to them what are, if we are starting a new topic I actually explain to them what is required of them to know from that topic before we will kick on with the lesson".*

The second question posed to Mr. Strong was about his views on the use of learners' prior knowledge on the topic distillation. The response to this question was: *"... So, what we do is before we start with the lesson, you actually find out what they know about certain things of that topic and so on and than from there you build on what they already put as a foundation".* When Mr. Strong was asked about his views on learners' understanding of the topic distillation he stated that:

> *"My views on learners understanding is that, ah the way the syllabi are structured is fine so far. But now when it comes to a teacher you yourself should to study how the learners understand. If they understand like let us say the outline the steps of distillation first and then you and show them the apparatus or you use the apparatus to show them to outline the steps. But I myself I have found out that it is easier to have them know the apparatus and from the apparatus then you build on the steps. Because the apparatus will be mentioned in the steps because if they do not have the ideas of*

the apparatus then when it comes to steps they get confused. So it's best they know the apparatus first before you outline the steps".

Since this study looked at teaching strategies teachers used when teaching the topic distillation, I prepared a question on the teaching strategies. Mr. Strong responded to this question as follows: *"... Our teaching strategy as I said is learner-centred and one of them is sending them out to find out more about distillation (they have to go and discover out for themselves like the end product of distillation and how this process is carried out in the industries not as outlined in the books)".*

When responding to this question, however, Mr. Strong highlighted that the factors enabling learners to understand the topic distillation was the use of scientific terms. In his own words: *"The factors are just the terms. If they don't understand the terms it's going to be difficult for them to understand the topic".* When I asked him to share with me the factors which make understanding the topic difficult, he indicated that he had not come across any so far.

The topic distillation is one of the more practical topics; I therefore asked Mr. Strong if he had all the materials needed to carry out the process of distillation. He stated the following: *"Ah, some material we do have, but most of the time what we do is we use visual aids".* He further outlined that the only problem he noticed with the learners on distillation concerned definitions of scientific terms. He explained that learners are used to English definitions and not science definitions. He said: *"So, we are encouraging them to get for themselves the science dictionaries, so when they are in the science class we refer them to the science dictionaries instead of the English dictionaries".*

4.3.2 Pre-Interview with Mr. Gaps

The interview questions of a semi-structured format were also used with Mr. Gaps. For interview question one on prior everyday knowledge Mr. Gaps maintained that "*since this is a science topic it is always good to give the learners the definition first, of the concepts that are involved on the topic of distillation. So, they have to know whatever definition of the terms that have been used first then from there you proceed".*

He replied to the follow-up questions on the introduction of the topic distillation saying: *"First you give them the chance to go and find out about the definitions themselves so that they can come to the class and discuss about it before you can give them the right definitions".*

According to Mr. Gaps on the question of eliciting learners' prior everyday knowledge he always considers it during his teaching (also see PEK Section 2.6). Mr. Gaps explained that *"... prior knowledge of learners is very much important role on learning because it gives a teacher a way on how can you build on for the understanding of the learners. Because these learners will always start from the beginning, you must know where this learner is ending so that you should be able to build on what the person knows already".*

Mr. Gaps's views on understanding of the topic distillation by learners reads as follows: *"Eh, learners they are there a bit but not really since they are still relying in the traditional way. They do not have ideas that these things that we are doing at home they are also part and parcel they are linked to science that we are doing at school. But if you look at the topic more, I think they will be able to link to what is happening in daily life".* It seems he was concerned about the importance of indigenous knowledge (IK) (see Section 2.7)

In reply to the question about teaching strategies used, Mr. Gaps highlighted that he always uses the learner-centred approach whenever presenting lessons including distillation. This is what he said;

> *"Eh, basically, when I am teaching this topic I use learner-centred education. As they said first the learners should be involved in doing the things. Therefore, much of the work should be done by learners. And then, my task is just to guide while they are doing the work. To make sure learners are doing the right things. And learners should do more and the teacher is just facilitating learning. But most of the tasks should be done by the learners".*

Mr. Gaps added that learner–centred is just the best approach. He strengthened this by giving reasons that:

> *"because these things of a teacher to be the expert that time the learning was not good at all. Because sometime you think that what learners are taking is correct but in real sense learners are not enjoying it. When they do things they enjoy it and when they are doing things they are keeping on remembering the things that will help them. Instead of just a teacher going there and preach at the end the learner get bored and will not enjoy and ends with no learning takes place".*

Mr. Gaps stressed that learning has to be done by combining the practical with the theoretical. Therefore, in order for learners to understand the topic distillation, learners have to do practical work. That is, they have to be hands-on so that what they learn about they also have to see so they know the outcomes of whatever they are doing and from there they will be able to grasp the content. When probed about materials needed to carry out the distillation process he pointed out the following:

> *"Ah, you see at our school now we are facing a challenge that our lab is not well equipped. Now we are trying to rely on things that are a bit of theoretical then from there we bring in things that we are doing in our houses. Like this topic of distillation, I always try to link it to their ways they brew their traditional alcohol here in the community. Because that one in science we can say that is distillation, because they normally use the same process of boiling contents and from there they collect alcohol that is the practical example of distillation. But now in real life here we are just using theoretical" (see Appendix H).*

Mr. Gaps mentioned a type of traditional alcohol prepared in his community as a practical example of the topic distillation. With this he touched a bit on the use of community knowledge or indigenous knowledge (IK) of learners (see Section 2.7). When I asked him to explain and elaborate on this traditional alcohol he mentioned *Kashipembe* as an example. In his own words:

> *"The name of the process… That one I can just say its process of simple distillation that they use to make traditional home brew that we call Kashipembe. Because normally, we use to mix the mangetti fruit, then from there they crush it and then they put it to ferment a bit and put in the pot then from there starts boiling it. Then they connect the condenser where they use to fill water. Then that content will start boiling and alcohol will drop off first before water. In other words, we are doing science in our community unknowingly" (see Appendix H).*

Mr. Gaps also highlighted some of the problems experienced by Physical Science teachers when teaching the topic distillation. He further stressed the problems he experienced, a lack of materials and the belief that science is difficult, "*When learners come to your class with that belief you really need to work hard to break that bond of that belief that says science is very difficult. Otherwise we are trying our best learners are coping"*.

4.3.3 Post-interviews

The purpose of the post-interviews was to reflect on what transpired during the lesson presentations. Now follows the questions posed and key extracts from the responses to each question for both teachers at the two schools.

4.3.3.1 Post-Interview with Mr. Strong

In the interview question about learners' prior everyday knowledge Mr. Strong stated that he used it when he gave examples that related to everyday science matters. One of the examples he gave was *"the sugar solution where you mix sugar and water, and then when you want to separate the two you can use evaporation as a technique"*.

Mr. Strong was confident that it was very important to study the topic distillation. He supported this by saying that; *"Yes, it was very important when it comes to distillation. Yes, because distillation is also used in rural areas to brew alcohol and I also used that to relate it to everyday use even though it is not encouraged that they should go and find the final product in rural areas which is alcohol itself" (see Appendix H).*

The teacher responded to the question about the use of teaching strategies by explaining that he used the learner-centred approach when he taught. I observed in the three lessons that the learners did most of the work. However, he posited that lack of materials had an impact on the teaching of the topic distillation. For this reason, the learners did not do practical work and what he talked about instead they just learned theoretically as usual. *"But with these what we actually do is we substitute where we cannot find the apparatus. We substitute these with videos of certain processes"*.

According to Mr. Strong on the question of whether the lesson went well or not, he maintained that his lessons went well because learners listened attentively. *"The other thing is that they participated and were more active. These make it to go well, because when it is learner-centred the learners should participate more than the teacher. And this is what has happened"*.

However, he said the test would reveal whether the lesson went on well or not, then, from the test he would go back and polish the parts which were not clear. Lastly, Mr. Strong suggested that:

> *"We actually don't limit them to ethanol and water when it comes to fractional distillation. We should also bring to them crude oil, petrol that we are using every day in our cars that they hear prices are rising is also separated using fractional distillation. And that there are other things obtained from using this like petroleum jelly, tar which we are using to construct roads and so on"*.

4.3.3.2 Post-Interview with Mr. Gaps

When I asked about considering learners' prior everyday knowledge (see Section 2.6), Mr. Gaps told me that he considered it when he asked the learners to give their own practical examples within their local environments. He added that it was very important to study about the topic distillation. He explained that *"whatever we are doing at school we ensure that these learners should apply it in their environments. These are the educative things we are doing and knowing these learners will have good lives".* This followed the question of the importance of studying the topic distillation.

A learner-centred approach was the answer given on the question of teaching strategies. Mr. Gaps said that learners where given a chance to give their views first and from there he built on their contributions. However, it was obvious that he only used chalkboard and posters (see Section 4.4.3). Therefore, *"it could be more understandable to learners if it was to be hands on. Learners have to see what they are doing and know every step we are doing in real life situation so that they can try to put it in concrete things. So, materials are very important in the teaching of the distillation topic".*

Mr. Gaps maintained that the lesson went well because the learners got the ideas and were able to differentiate between the two types of distillation (simple and fractional distillation) using figures on the chalkboard and poster.. It was evident that *"this other one has columns, we talk of fractionating column for fractional distillation while the other one of simple distillation did not have that column" (see Section 4.4.3).*

However, the lessons did not go well in all aspects. In his own words:

> *"Some learners still have this misunderstanding of these concepts that we normally used. So, like when we came to* ***solution*** *how solution is being formed some learners find it difficult which solution is this one. They even failed to find out what are the substances which make up a certain solution. That was the things that I saw did not go well there".*

Mr. Gaps suggested the following when he was asked to make general comments or suggestions about all the lesson presentations and the whole phase of the study.

"I think for that thing to be properly done. I am suggesting of going to our TRC (teachers resources centre) now, so that we can try to get some materials if possible. If not then I will try to get a video so that they can see properly on how the stages and step use to be done during this type of distillations. I think those ones will be ok. Now we using like theoretical things but if we will bring things like a video will do better. Because they can see, it can also be repeated for them to see how the practical steps are being explained".

4.4 Observation of the lesson on distillation

Observation of the three lessons was one of the main data gathering techniques which I used for both teachers at the two schools. This technique was used in order to complement the data gathered through semi-structured interviews and document analysis. Lessons for each teacher were 40 minutes long for both school and these was videotaped.

During the lesson observation I looked at the use of teaching strategies to teach the topic distillation, elicitation of learners' prior everyday knowledge (PEK) as well as incorporation of indigenous knowledge where possible.

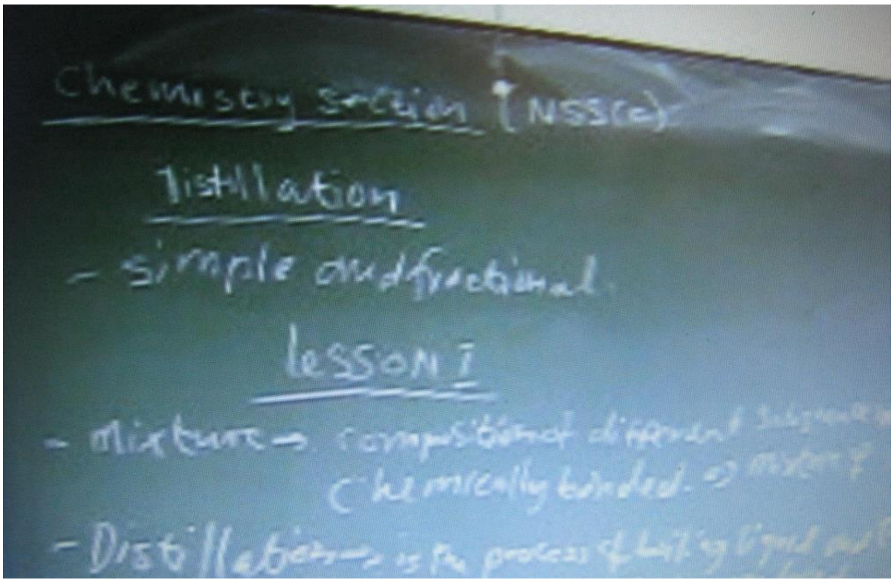
4.4.1 Lesson 1: Day 1

4.4.1.1 Tushetekenu Secondary

The teacher introduced me to the class and told the learners that my stay at the school was for study purposes in the field of science education.

Mr. Strong did not divide the class into group stations and the learners were seated in six rows. The class was overcrowded with 50 learners in total instead of the recommended 30 learners as per teacher-learner ratio in Namibian government schools. He did not greet the learners when he entered the class but started talking immediately. He mainly used the chalkboard (Figure 4.4.1.1 (a)) and textbooks as the learning and teaching support materials (LTSMs) during the lesson.

Figure 4.4.1.1 (a) shows how the teacher used the chalkboard to give notes to the learners.



He then started with the lesson by first explaining the topic of experimental techniques to the learners and its concepts. Then he wrote the topic distillation on the chalkboard. Mr. Strong started asking the learners questions about experimental techniques. In the teacher's introductory sentence it seemed as if the teacher had already begun the topic and this was a continuation of the lesson, or maybe he told the learners to go and read about the topic as reflected in the following sentence: "*Today we are going to continue with experimental techniques. Now I would find out if you have been reading. Or you just went home and closed your books until now"*.

Learners were introduced to the terms involved in experimental techniques as per the Namibian Physical Science syllabus 2010. This lesson comprised an introduction of the experimental techniques or concepts. The whole lesson concentrated on the definitions of most of the concepts associated with the experimental techniques - which included distillation - in the syllabus. The lesson was presented mainly by using the question and answer method. For instance, the teacher posed questions to the learners about definition of concepts used under this topic. Below is some of the conversation between the teacher and learners during the lesson.

Excerpt 1

T: *So, who is going to tell me what a* ***mixture*** *is? (****repeated it****). Ya,* ***Kasoma.***
L**:** *Two or more elements that are not chemical combined.*
T: *Good. So we have different types of mixtures, isn't?*
LLL: *Yes sir*
T: *Can you give me these different types of mixtures with an example?*
LLL: *[murmuring]*
T: *Ya*
L: *Sugar and water.*
T: *Sugar and water, what type of mixture is that? Ya*
L: *Solid-liquid mixture e.g. salt and water and liquid-liquid mixture and etc.*

Evidently, Mr. Strong started his lesson by doing a recap of what he had already done. For instance, he said:

> "*So let us recap on what we did. We started off with mixture, which is a composition of two or more substance which can be element or compounds that are not chemically combined that is very important. You can have a mixture of sodium and potassium provided that they are not chemically combined. Once they are chemically combined they become a compound not a mixture anymore. Then we went to different types of mixtures. Solid –solid mixtures; sand and sugar, liquid –liquid mixtures; water and ethanol, liquid –solid mixture; water and sand. Then defined soluble, as the ability of the substance to dissolve. Then we went on defining insoluble, the inability of the substance liquid or solid to dissolve*".

The way the teacher started by asking the learners to mention what they had read about the topic suggests that the teacher thought about his learners' prior everyday knowledge (see Section 2.6). He also did this by asking learners to use everyday examples that are related to science matter. For instance, asking learners about "*mixing sugar and water to form a solution*".

The teacher further referred the learners to check the definitions of the terms or concepts in the textbook. He asked them to take out their exercise books and write down some notes. He then took out the prepared notes from his file and started writing on the chalkboard for the learners to copy. This shows that the teacher used the textbooks and chalkboard as the learning and teaching support materials (LTSMs) to deliver the lesson content to the learners. The conversation between teacher and learners are shown below.

Excerpt 2

T: *Take out your exercise books.*
LLL: *Monday [learners requesting to write the notes the next day]*
T: *No no no, we do not have time to waste [denying learner's request].*

LLL: [learners just making noise]
T: [writing on chalkboard learners where still making noise]

When the learners started writing the notes, no teaching took place again until the period came to an end and the learners moved to the next class for the next period.

4.4.1.2 Yebo Secondary School

The teacher first greeted the learners before commencing with the lesson. However, he made a mistake when he greeted morning instead of afternoon, maybe he was nervous. Both teacher and learners did not notice that they made such a mistake; I only discovered it when I watched the video during transcribing.

Excerpt 1

T: Good morning class.

LLL: Good morning sir.

T: How are you this afternoon?

LLL: We are fine and how are you sir.

T: I am fine. Let us start with the work of this afternoon. I want you to be in groups. And you must not forget to write your name on the paper in your group.

The teacher started the lesson by telling them to sit in groups of five to six learners and they formed seven groups. This teacher had learner-centred education in mind as he stated during the pre- and post interviews (see Appendix H). The teacher started asking questions on defining scientific concepts in the topic of experimental techniques. He explained that *"We are looking at definitions which we normally use in science especially distillation. The first substance that we are looking at is a mixture. What is a mixture?* One learner responded that it is *"A substance that contains more than one substance".* The teacher did not explain any of the terms before asking the learners to define terms. This indicated that the teacher was eliciting learners' prior everyday knowledge (PEK) of concepts under experimental techniques which include distillation.

The whole lesson was about defining concepts used in the topic of experimental techniques. At some point, the teacher re-defined the term to make sense of the concepts to the learners before moving to the next concept. For instance: *"In short we say **soluble** means to dissolve in something or in a solvent"*.

Mr. Gaps explained the concept of fractional distillation by asking learners about the traditional brew which they make at home using mangetti fruits. This concept highlights the importance of using indigenous knowledge (IK) during the teaching and learning of science concepts. However, the teacher also code-switched at times to emphasize a point and to try to make sense of the concepts used in the topic. This information is contained in the excerpt below.

Excerpt 2

T: *But, in this case now is fractional distillation they are all liquids we mixed them together. Now how do we separate them? So, we use this method because each liquid have its own boiling point. We will look at the boiling point later on. So you boil the two liquids, they are all mixed. Now how do we separate them? You boil all of them. Therefore it boils at its own temperature. Bring my chalk. Each liquid will boil at its own temperature. For example; how do you make alcohol at home? This drinks you are making from mangetti.*

L: *Kashipembe.*

T: *Ehe. Do you know how to make it?*

L: *Yes.*

T: *Something is mixed with solid things and water eh.*

LLL: *Yes.*

T: *There are solid things inside there, plus water they are mixed together but now; we want to take out alcohol called Kashipembe. How do we do it? You boil it neh.*

LLL: *Yes.*

T: *Then from there the alcohol called Kashipembe will evaporate. And pass through that tube and we use to put water there is that clear?*

LLL: *Yes sir.*

T: ***Momuyengo** Eh [Code switched]. Now in the pipe where you are putting water in science we called it a condenser. Because that water will be cold neh. The thing that you are evaporating from the pot is very hot neh, when it reaches that muyengo there its cold then it starts condensing there and changes into water, from there the Kashipembe will be collected in the other part. So we are doing science at home without knowing that that is science you are doing. So that muyengo we call it a* *condenser in science because it's the one that use to cool things down. And then, condensation? Repeated again.*

The teacher defined a term succinctly so that it could be easily understood by learners: "*A solution is a mixture of a solvent and a solute. For example,*
Solvent + solute $\longrightarrow$ *solution*".

This teacher considered learners' everyday knowledge throughout the lesson by giving examples after explaining some of the terms which could be contextualised.

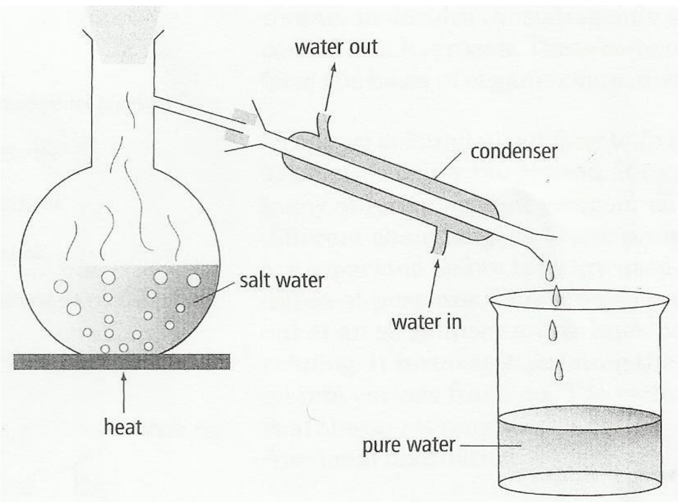
4.4.2 Lesson 2: Day 2

4.4.2.1 Tushetekenu Secondary School

The teacher started this lesson by recapping and building on what he had taught in the previous lesson. This was intended to move the learners from what they knew about the definitions to the new topic. The teacher used the elicitation of learners' prior everyday knowledge (PEK). The lesson dealt mainly with the steps involved during the distillation processes.

The teacher asked learners to look at the figure of apparatus used in the textbook of NAMCOL Module (see Figure 4.4.2.1 (a)).

Figure 4.4.2.1 (a) Simple distillation Kachinda and Ajayi (2009: 11)



He started asking the learners questions based on the figure above.

Excerpt 1

T: Ya, i am talking to you guys. Why do we need a heat source in the process of distillation? [no learners responded] Ok, let's put it this way which properties of an element do we consider when we are using distillation? [Pointed at a learner]

L: Boiling point

T: Who wants to try? Properties of the mixture when you want to..Which properties of the mixture do you consider when you want to use the process of distillation?

L: Boiling point

T: She was right. Boiling point. Different boiling points ***[repeated]****. Tom, why do we need a heat source? Who wants to try, why do we need a heat source? Ya [Pointed at a learner]*

L: To separate the substances like the ones that have different boiling points.

T: ya, we need the heat source for us to attain the different boiling points. Is it clear? We need the heat source in order for us to attain the different boiling points. Without the heat we wouldn't have attain the different boiling points. And a thermometer, why do we need it? Ya.

L: We need it to take the temperature.

T: Temperature, Why do we need to take temperatures with this apparatus? I mean in this process. Ya.

L: To find the boiling temperature of substances.

T: Ya, to find the ...

L: To find the boiling point of substances.

However, the teacher asked the question about temperature which introduced the thermometer. But looking at the figure he referred learners to; it did not include the thermometer which I think might have confused some learners. From there he continued asking questions about the apparatus used in the figure and explaining their purpose. Later on he asked the learners to close their textbooks and asked them questions in order to recap on the apparatus used during the distillation process.

After naming the apparatus the teacher asked the learners to explain the process of simple distillation in their own words.

Excerpt 2

*T: So, who is willing to tell us or brief us on the distillation process? Let us use the salt solution [**repeated]**. Hmm. Salt solution, the distillation process using the salt solution? Yes **Kasoma.***

L: First the solution is boiled, and then it changes to vapour. Then the vapour is condensed in the condenser. When vapour passes through the condenser, it will be condensed up and in return the vapour changes to water and be collected in the receiver as distillate. And in the flask the salt will be left in.

T: Very good. I could not explain it better myself.

LLL: Not clear.

T: Not clear, can you repeat it?

L: Yes sir. Firstly, the solution is boiled after being boiled it changes to vapour. The vapour is passed through the condenser and the vapour will be cooled and changes to liquid which will be received in the receiver. And in the flask the salt will remain.

*T: Yes. What evaporates is the solvent, eh! The solute remains behind. The solvent get trapped in the condenser and be cooled and get back to liquid. Then it drips down into the flask receiver where you find pure liquid. In this case it will be **distilled water**. So, let me see if the boys were listening.*

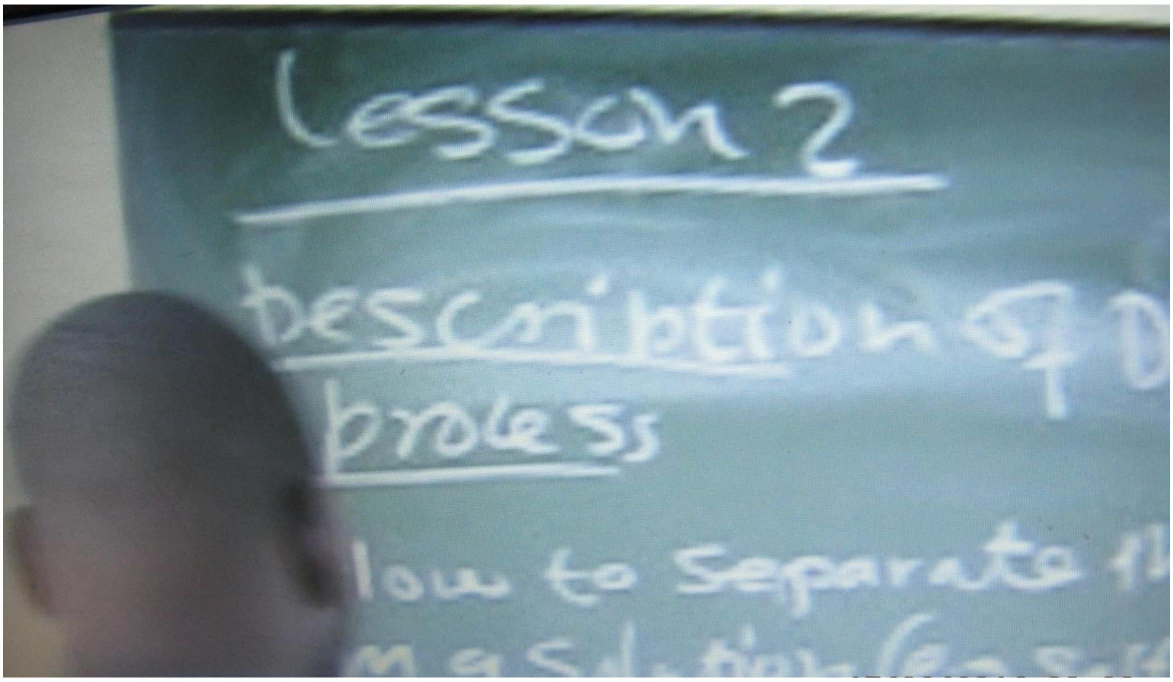
During this lesson I noticed more teacher talk. The teacher introduced the concept of fractional distillation and explained the process without asking the learners whether they could attempt it first, thereby neglecting an opportunity to establish their PEK. With reference to his responses during pre-interview he said the following: *"Distillation! Ah, our teaching strategy as I said is learner-centred and one of them is sending them out to find out more about distillation"*. This to me was a contradiction with learner-centredness as what he stated in the interview about teaching strategies was the opposite to what happened in the classroom (see Section 2.3). The excerpt below shows where this teacher used teacher talk during his lesson two.

Excerpt 3

*T: Liquid to gas. Meaning both will change states at same temperature. That will evaporate will condense and at the end of the process you will won't get pure ethanol or purified ethanol. Because water will also be in that ethanol. At the end of the day we will end up getting a mixture. This is where **fractional distillation comes in.** It is the same they use the* *same apparatus. But now there will be a different of addition of* ***fractionating column.*** *The fractionating column contains beads, glass beads. So when you heat your mixture they will all evaporates at once. Ethanol and water will evaporate.* ***When they reach the fractionating column the beads condensed these two liquids. Now they reach different boiling points, ethanol at 78*** ^{0}***C and water 100***^{0}***C****. Now what you have to do is watch your thermometer. Before you start boiling and while you are boiling. When water and ethanol will evaporates and condensed at the beads, glass beads, the temperature will again rise. The temperature of the beads will rise to 78 degree Celsius. At this point the ethanol boils off it goes into the condenser, its condensed. Change of state from gas to liquid and then it drips off leaving the water behind in the fractionating column. It drips into the receiver. But once the temperature increases from 78 degree Celsius then you have to switch off the Bunsen burner. Meaning the ethanol has been all evaporated. Simple as that, simple distillation process with an introduction of a fractionating column. Guys you are very quiet and mute.*

The teacher's last sentence in the excerpt was also a good sign that the learners were bored as they were "*quiet and mute".* The following figure 4.4.2.1 (b) shows the teacher writing some notes on the chalkboard for learners to copy.

Figure 4.4.2.1 (b) The teacher was busy writing notes on the distillation process on the chalkboard



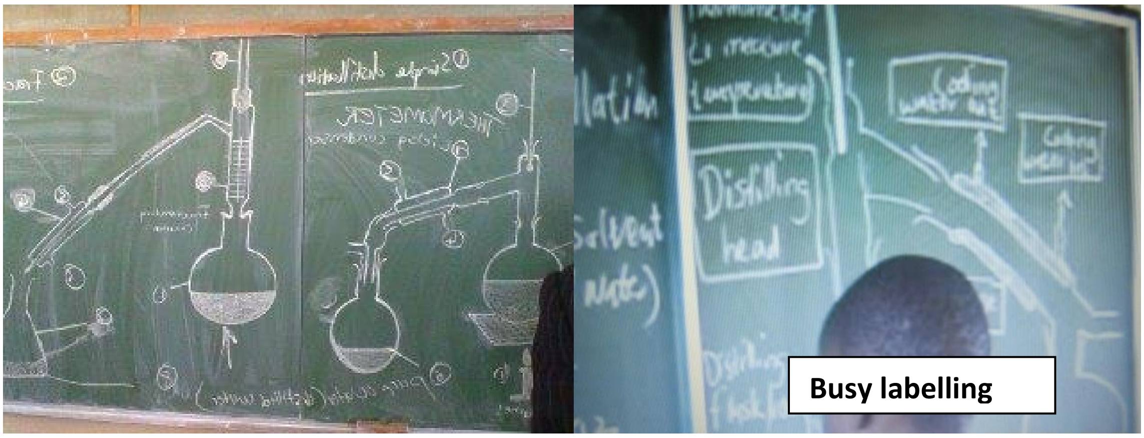
Lastly, the teacher asked one learner to explain the process of distillation as he had explained it to the class to summarise the lesson for the day. Then he told the learners to go and read so that they could answer questions during a recap of the lesson the next day.

4.4.2.2 Yebo Secondary School

This lesson was a continuation of the previous lesson. But the second lesson concentrated on the steps involved in the distillation process. This lesson was presented by using the figures of simple and fractional distillation as references to explain the steps and concepts around the distillation process. After the explanation the teacher asked the learners to label the names of apparatus used on the figure. This activity was a verbal one where learners did not write in the exercise books instead they answered on the chalkboard individually. This revealed the correct usage of a chalkboard as a learning and teaching support material (LTSM).

Figure 4.4.2.2 (a) below shows the two figures on the chalkboard which were used during the teaching of the topic distillation and a learner labelling during the oral activity

(a) Figures on chalkboard **(b) A learner busy labelling**



The teacher wrote the main content of the lesson which is the descriptions of simple and fractional distillation on the chalkboard. Before he started with the lesson he asked the learners to define some terms which had been discussed during the previous lesson. Thereafter, he asked learners to mention what they knew or had heard about the topic simple distillation. The learners explained the making of *Kashipembe* as an example of distillation being carried out in their community.

Excerpt 1

T: Which means there is water and salt mixed together. Now, if you want to separate them, because you put salt in water they completely mixed neh?

L: Yes

T: Now, how will you separate them? Now we use to separate them through the process we call simple distillation. How do we do it? First thing is we must heat them, how can we heat them? we must put it under the fire eh? Then from there when you heat these liquid what will happen? What do you think what will happen?

L: It will boil.

T: Starts boiling eh?

L: Yes.

T: From boiling it does what?

LLL: It start evaporating [Chorus]

T: One person. From boiling, when you heat a liquid what happens?

L: Boiling.

T: It starts boiling eh? From boiling it stops at boiling?

L: No.

T: What will happen? You rise up your hand if you want to say something not singing like in the church ah?

L: It starts evaporating.

T: It starts evaporating ah?

LLL: Yes.

T: That is the logic behind here. So, when you heat a liquid the liquid will start evaporating eh?

LLL: Yes.

T: When it evaporates it moves up here. Don't forget that this part [Teacher pointing on the displayed figure of simple distillation] is closed, completely closed. Therefore, after evaporating it must pass through here [pointing on the chart see figure 4.4.3.2 (a)] and this one we call it a condenser. A condenser, when we are doing Kashipembe that muyengo we put water in neh?

L: Yes

T: For water to be cool. So, when this air is hot it starts evaporating. When it reaches a cool place it starts condensing is that clear.

LLL: Yes sir.

4.4.3 Lesson 3: Day 3

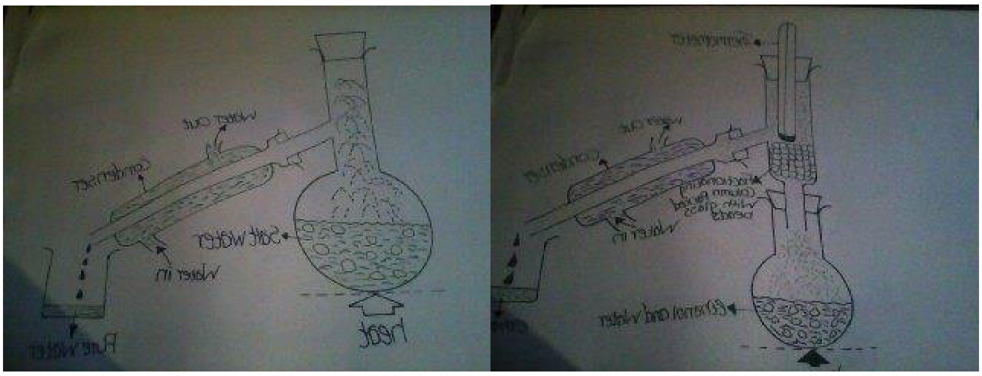
4.4.3.1 Tushetekenu Secondary School

This lesson was mainly on the quiz based on the content covered during the previous lessons. These were mainly on the experimental techniques in general. The teacher started by distributing a quiz handout to the learners. The learners were allowed to work in pairs to complete the quiz. The whole period was used for this activity. The teacher explained: *"It is a multiple choice quiz. Eh, it's a multiple choice quiz. You write your name on the paper and answer on the paper".*

4.4.3.2 Yebo Secondary School

The lesson started with some greetings by the teacher. The teacher first asked learners to explain what was learned the previous day. Learners were able to give answers and describe the steps involved during the distillation processes. The lesson concentrated on the identification and differentiating between the two figures of simple and fractional distillation. This was done by displaying the poster on the chalkboard and learners were asked to identify the two distillation processes. The chalkboard was still used as an additional support material (see Figures 4.4.2.1 (b) and 4.4.2.2 (a)). Some learners managed to identify the simple and fractional distillation from the figure and were able to label the apparatus on both figures.

Figures 4.4.3.2 (a) Simple distillation (b) Fractional distillation



4.4.4 Lesson 4: Day 4: Tests

The test was based on the topic distillation which was taught during the three lessons. At Tushetekenu Secondary the test was marked out of 20 and at Yebo Secondary the test was marked out of 38 (see Appendices G (ii) and (iii)). The purpose of both tests was to test the learners' understanding on the topic of distillation.

The passing requirements in Physical Science Grade 8-12 for learners in Namibian schools should be at least A-D which is A (80%-100%), B (70%-79%), C (60%-69%) and D (50%-59%). However, E and F which is E (40%-49%) and F (30%-39%) are regarded as a pass on the report card given to the learners, but an E in Mathematics and English as Second Language is a fail. The learners who obtain U (0%-19%) and G (20%-29% are regarded as failed and these symbols are circled with red pen on both report card and promotional schedules.

The majority of the learners at Tushetekenu Secondary school obtained 55%-85%, which shows that most learners passed the test as per the A-D requirement. The learners at Yebo Secondary also performed well with most of them ranging between 66%-97%. The test results of learners at both schools indicated that the learners understood the lessons taught on distillation.

4.5 Teachers' pedagogical content knowledge

4.5.1 Prior teaching strategies

The teaching strategies used by both teachers were more of a question and answer method. This was supported by the data collected during pre and post interviews with both teachers (see Appendix G (viii)). In some cases there was teacher talk when explaining concepts to the learners. Mr. Strong tended to lecturer or talk most of the time in conflict with his sense that he used a learner-centred approach. The teachers used lecturing as a strategy to teach the topic distillation to the learners for scientific meaning making.

Different teaching strategies were employed by the teachers in an attempt to make sense of the topic distillation. For instance, Mr. Gaps used learning and teaching support materials in addition to the chalkboard to deliver the content to the learners, making use of charts or posters containing figures of simple and fractional distillation. The posters were supported by magnets when displayed on the chalkboard. These enabled the learners to make sense of the topic distillation.

4.5.2 Elicitation of learners' prior everyday knowledge (PEK)

The use of learners' PEK was one of the strategies used to explore the topic distillation during the teaching. Both the teachers elicited their learners' PEK throughout their lessons. This continuous use of what learners' already know helped the learners to make sense of the topic. They did this by asking the learners to present their views about a certain concept on distillation and they explained the traditional brew of *Kashipembe* made from mangetti as one relating to everyday experiences. The learners' input on the making of *Kashipembe* helped them to grasp the ideas and connections of school science and the science at home.

4.5.3 Meaning making of concepts on topic distillation

Both teachers tried to explain concepts to make them more understandable to the learners. Below is an excerpt taken from transcript of Mr. Gaps (see Appendix G (viii)).

Excerpt 1

T: Very good. Listen here, the function of this thing in order to condense this water (teacher pointing at figure on chalkboard). When you heat water, it evaporates and now water is in the form of the gas neh?

L: Yes.

T: Now, which means when it reaches here this place is very cold, now this evaporated water will be changed into a liquid form. That's the function of it. Eh, let's try to recap on this. We are saying the solution is heated in the glass as we said. It boils and steam rises into the condenser, the salt is left behind in the flask. Now we say when you heat the solution the water will start evaporating and what is left here is the salt. To be left behind this is a flask [Teacher pointing at figure of a flask on poster] see figure 4.4.3.2 (a) and (b). So, then the condenser is cold, the steam which is hot will condense. It means when the steam is condensing it is changing from gas to ...

Brief Summary of this Chapter

The analysed documents helped me to gather information on the topic distillation. The figures presented in these textbooks were useful to both teachers and learners. The illustrations and figures of male and female learners conducting experiment in textbooks encouraged learning and understanding. The analysed textbooks gave me insight into how the topic distillation should be taught by Grade 11 Physical Science teachers. I felt that this topic should be included in the lower grades as well to make it more understandable in Grade 11.

The use of different teaching methods during teaching by the two science teachers supported the learners in making sense of the topic distillation. It was clear that both teachers attempted to practice both a learner-centred approach and the question and answer method to make sense of the topic. But later on the emphasis was more on the question and answer method which was supplemented by chalkboard, printed materials and charts or posters (see Appendices H (v) & (vi)). The correct use of textbooks, posters and chalkboard by the two Grade 11 Physical Science teachers helped the learners to know and understand the conceptual topics on distillation (see Section 4.4). The continuous elicitation of learners' prior everyday knowledge with the integration of indigenous knowledge in their community helped the learners to understand the topic better.

However, both science teachers pointed out that the lack of teaching apparatus constrains the sense making of learning in science (see Appendices H (i) & (ii)). These apparatus include: condenser and fractionating column just to mention the few. Theoretical knowledge given to the learners by the science teachers in the form of notes without the advantage of practical work, hindered the teaching due to the fact that our public school laboratories are not well equipped and some have no school library at all.

The teachers explained that in order to respond to the above challenges, the teachers should ensure that learners do science which is hands-on for them to understand the topic better. My participants emphasised that teachers should do practicals with their learners during teaching to develop meaning making of the concepts on distillation (see Appendix H (ii)). On the other hand, one of my participating teacher felt that the definitions of scientific terms needs to be addressed as this was one of the factors which made learners struggle with the topic distillation (see Appendix H (i)). This highlights the importance of the correct usage of scientific language and the drawback of English as a Second Language as the LoLT during Physical Science teaching and learning.

4.6 Concluding remarks

In this chapter, I presented that data gathered at the two research sites as they were described in Chapter 3. This chapter presented findings from the document analysis, observations on three presented lessons, interviews and a test. Primarily, the data revealed how both teachers teach the topic distillation using the teaching strategies at their disposal. It was also clear from the presentations that the eliciting learners' prior everyday knowledge (PEK) is important throughout the lesson to establish what level the learners are at. Furthermore, the data indicated that using both teachers' and learners' knowledge and experiences would provide support to help the learners make sense of scientific concepts like distillation, especially in rural schools.

In the next chapter I present the second phase of data presentation which derived mainly from brainstorming session on distillation with learners on making *Kashipembe*, data from the semi-structured interview with learners and a community member on making *Kashipembe* and the development of at least two model lessons working together with two grade 11 Physical Science teachers.

CHAPTER FIVE: DATA PRESENTATION: PHASE TWO

> *Holistic approaches to qualitative data presentation will want to catch the wholeness of individuals and groups, and this may lead to a more narrative, almost case study or story style of reporting with issues emerging as they arise during the narrative (Cohen, Manion & Morrison, 2011: 552).*

5.1 Introduction

This phase two aims at answering the third research sub-question, namely, *In what ways can Grade 11 Physical Science teachers improve their teaching strategies when teaching the topic on distillation?*

In this chapter I present the data from the following sources: data from a brainstorming session on distillation with learners on making *Kashipembe*, data from a semi-structured interview with a community member on making *Kashipembe,* data from a semi-structured interview with the learners and the development of at least one model lesson created together with two grade 11 Physical Science teachers.

As alluded to in the epigraph above, the data from the brainstorming session and interviews is described mostly in the respondents' own words. The brainstorming session and interview with learners and the interview with the community member is more procedural. For this reason I felt that I should include all the data in the transcripts to make it clear to the reader.

5.2 Data from brainstorming session (Lesson) on distillation with learners on making *Kashipembe*

This section attempts to understand how science teachers can improve their teaching of distillation with the integration of the making of *Kashipembe.*

Throughout this session, the class discussion on making *Kashipembe* was led by me as a researcher. I used a question and answer method to probe their knowledge of the making of *Kashipembe*. The main purpose of the brainstorming session with the learners was to find out their prior everyday knowledge (PEK) and indigenous knowledge (IK).

The knowledge obtained here could be used by teachers to improve their teaching of distillation and make it more understandable to their learners. During the discussion I wanted to use the local language spoken in the community but the learners themselves decided that I should use English. However, some concepts and apparatus were mentioned in a vernacular language *Rumanyo* and these are in *italics* as indicated in the write up but they are translated into English. The choice of using a language the learners makes it easier for them to express themselves and aids understanding of the topic. The learners were eager to participate and share the knowledge they have about making *Kashipembe* in different communities of Kavango East and West Regions. The questions are as follows:

IQ.1: What types of fruits are being used in the community to make *Kashipembe*? You may just mention it in the vernacular (Rumanyo) then we will translate it in English together as a class.

L1: Mangetti fruits (Ngongo)
L2: Orange from the forest (Maguni)
L3: Berries (Mpundu no Makopa)

IQ.2: Explain how Kashipembe is made? Give the step by step procedures. Here you are required to list the step by step procedures on how *Kashipembe* is made.

L1: When you are using the mangetti fruits (ngongo).
First you take the mangetti fruits, and put it in a metal drum, pour in water, put on fire and let it boil. When it turned its colour you take it out and pound it. And mix it. But you should leave out some to serve as yeast. After that you leave it to last for two days. When it has fermented you can then start distilling (process of distillation) to get Kashipembe. But readiness depends on the person who prepared the content mixtures, some takes only two days other takes longer (we call it ruwoko).

L2: How to make *Kashipembe* with mangetti fruits
First of all you boil it, after boiling put it on the ground and starts pounding to remove out the flesh (ghutumpi) and the skin/covers (vipapa). From there they mix the cover/skin and flesh with water and put in the plastic/metal drum (ndoroma). While the hard nut-like seed (vigongotji) is put aside. And leave it to ferment. After fermentation, distillation process will

then start using another metal drum for boiling (ndoroma yokuterekera) again, and then Kashipembe is received from condenser (muyengo).

L3: How to make *Kashipembe* with mangetti fruits

Firstly, you have to go in the forest and collect mangetti fruits with a sledge pulled by oxen (shireyi). You take all the mangetti you want to use and put in a big container, pour in water and put on fire to let it boil. You boil it just like you are cooking something. After boiling it, you pound it using a pistle and mortor to remove out the cover /skin (vipapa) together with the contents (ghutumpi). Then, you put it in the big container to mix it with water. Put mix contents in a big container and cover it so that you can leave it for two days. When it is ready (fermented) then you can start with distillation process. You put the fermented contents in a cooking drum (Kanyungu kokuterekera) and put on fire wood, the put on fire. You keep on stirring it several times. When it starts to boil, cover it with small zinc sheet (shipereki) and put on mud on top of it. Mud will stop smoke from coming out through the opening. The steam will go into a condenser (Muyengo). Then, put water in condenser to cool it. Eventually, water drops out of the condenser and collected as distillate (Kashipembe).

IQ.3: What apparatus/materials are used to make *Kashipembe*? With this question you may just mention the materials in the vernacular (Rumanyo) then we will translate it into English together as a class.

L1: *Round bottom flask (boiling metal drums, ndoroma yokuterekera)*

L2: *Glass rod* ***(****stirring stick, rupandi)*

L3: *Condenser (metal pipe inserted into a wooden trough, (muyengo)*

L4: *Bunsen burner or heat source* ***(****Firewood, vikuni)*

L5: *Tripod* ***(****Metal or stone supports, makankara)*

L6: *Matches (kaparu)*

L7: *Water (mema)*

L8: *Stoppers (zinc sheet, sipereki)*

L9: *Stoppers (mud /clay soil, shighuru ndi lirova)*

L10: *Conical flask (cut cans or1 litre bottles (makende) or a cup)*

L11: *Heat source (grasses, mushoni)*

IQ.4: Who normally makes *Kashipembe* man or woman?

L1: *Woman, normally old woman makes Kashipembe.*

IQ.5: How many days can it take to make *Kashipembe*? And give a reason to support your answer.

L1: *Two days, for it to get ready (fermented).*
L2: *It takes almost more than two days, as it involves the collection of mangetti from forest and all the work of preparation.*
L3: *It takes a week, because one day for collecting mangetti, second day for cooking and pounding together with mixing. You add sugar the next day. Then, you leave it for three days to ferment before you start distillation process.*
IQ.6: *Why will you add on sugar?*
L4: *To make Kashipembe much more alcoholic concentrated.*
L5: *The one without addition of sugar ferments faster than the one with sugar added to it.*

IQ.7: Who is allowed to drink this *Kashipembe*?

L1: *Old people*
L2: *People above the age of 16 years*
L3: *Old people especially between thirty and forty years, reason being that they are used to drinking alcohol.*

IQ.8: What are some of the scientific concepts or terms associated with *Kashipembe?*

L1 - 14: *Fermentation ; Distillation ; Evaporation ; Distillate ; Boiling ; Condensation ; Filtration ; Miscible ; Heating ; Purifying ; Sorting ; Mixing ; Diluting and Tasting.*

IQ.9: Do you think the making of *Kashipembe* is a good practice or not in the community? And support your answer.

L1: *Not a good practices, because it can make people drunk and kill people.*

L2: *It is a good practice, because when you are making more Kashipembe you are making money.*

L3: *Not a good practice, because people who use it sometimes use to beat other due to its access.*

L4: *It is a good practice, because it makes old people to be drunken even young people when drinking it.*

L5: *It is a good practice, because it makes all the man and boys to come together when they are drinking Kashipembe. It makes people to discuss their stories and share ideas when they are drinking it. But it is not good practice because it makes someone to be a killer by drinking it when you are drunk.*

L6: *Not a good practice, because it can cause throat cancer. Good example is that man who died last year because of throat cancer due to Kashipembe.*

L7: *Good practice, because it is improving the living standard of people who are selling it. On the other hand it is a bad practice, because bring bad habit to the community and the families.*

A brief analysis of the above data derived from the brainstorming session on distillation with learners on making *Kashipembe*

The brainstorming session showed that learners have prior everyday knowledge (PEK) of a distillation process in relation to *Kashipembe* which can be used by the teachers to improve their teaching practices in the classroom. This was indicated by the answers they gave. The detail that learners provided on the ingredients and the steps in the process was quite striking. (see IQ.2.L3 above in this section). The PEK which the learners have can be used by the Grade 11 Physical Science teachers as a basic step in their development of teaching for understanding and for the learners' conceptual understanding.

The variations in some of the ingredients used were notable. It was evident that the people in the Kavango region used different fruits to make *Kashipembe* but the most common is that of mangetti and forest oranges (monkey oranges). This can be used by the teachers as an example on how the distillation process can be linked to other practices in the classroom.

The brainstorming session indicated that Grade 11 Physical Science teachers should find a way to teach the learners the pronunciations and spellings of concepts around distillation. This arose because I noticed that learners where unable to say some of the materials in English and vice-versa. For example, IQ.2.L2, mentioned *vipapa* instead of the cover or skin of mangetti fruits. Mainly learners found it difficult to name parts of mangetti fruit like its 'hard nut-like seed' was called *vigongotji* in the vernacular language Rumanyo and they did not have an English term for it. The teachers could use this information from the brainstorming session to encourage their learners to be able to identify materials in both the vernacular and English which could help to enhance their understanding of the topic.

The learners pointed out what they saw as some benefits of *Kashipembe* being used in the community such as: IQ.9.L1 *making money*, L5: *makes all the men and boys to come together* and L7: *it is improving the living standard of people who are selling it*. This would add to their basic knowledge of the process of distillation.

On the other hand some learners saw the presence of *Kashipembe* as having a negative influence on the community, such as it causes throat cancer; fighting and drunkenness (IQ.9. L1, L3 and L6). Again, these opinions could be used by the Physical Science teachers to add layers onto the lesson.

Thus, the session indicated that the knowledge learners have can be used by science teacher to improve their teaching by adding the economic and cultural aspects to the topic.

5.3 Data from semi-structured the interview with a community member on making *Kashipembe*

This interview was conducted in order to answer my third sub-research question which is: *In what ways can Grade 11 Physical Science teachers improve their teaching strategies when teaching the topic on distillation?*

The interview was in the form of a pre-arranged field visit to the home of the community member in order to hear her views on how she makes *Kashipembe* at home. The aim was to use her ideas to improve the teaching of the topic distillation in schools. I also needed background information on the process before the demonstration took place in front of the students. The brief analysis of the data derived from the interview with a community member can be found at the end of this section.

IQ.1: Nyango munke mwaruwanitanga murenke Kashipembe?

RT: What types of fruits do you use to make *Kashipembe*?

CMR: Kwaruwanitanga ngongo, nkekete, mpundu ntani no makopa. RT: We normally use mangetti fruits, nkekete, mpundu, makopa (these are types of berries).

FQ: Podino nyango munatwenyaura, nyango munke mwaruwanitangapo unene?

RT: Amongst the mentioned fruits, which one do you use most often?

CMR: Atwe unenepo ngongo ndo twaruwanitanga.

RT: Mostly we use mangetti fruits.

The figure below shows what mangetti fruit looks like before it is put in the metal drum for boiling.

Figure 5.3 (a) Mangetti fruits *(Ngongo)*

IQ.2: Lipuro lyokukwamako, walye tutante tupu maghuyivi ghenu weni mwaruwananga Kashipembe? Yira weni omo avarekanga kadidi-kadidi tupu vene mukuwapayikira dogoro kukakendja.

RT: Next question, would you please tell me your experience or what you know about how you make *Kashipembe* step-by-step from the beginning of preparation to the distillation process?

CMR: Omotwarenkanga:

- *kughupa ngongo kutura mulitoromani (metal drum);*

- *makura oteremo mema ntani kuhamekako mundiro divire;*
- *apa dikutjindja ruvara makura kughupako mundiro ntani kudighupamo ghuditure palivhu;*
- *makura kughupa sinu (pistle) no muntje (mortar) otameke kudishopora;*
- *Pakumana kudishopora makura ododuhwire pa sipereki (zinc sheet) utameke kutoghorako dinya ngongo twatwenyangashi vigongotji (hard nut like seeds);*
- *Makura apa mumana kutoghorako vigongotji omuvikutulire. makura kughupa vigongotji kuvitura mundoroma kuvi kwayura mumema ntani kuvighupamo mukaviyaneke;*
- *Makura kughupa utura (mixture of outer skin and flesh) kughutura momo mumema ghovigongotji mundoroma yokurungira (drum for mixing) makura kuvikosha (mixing);*
- *Makura kughupa suka (sugar) kuturako. Makura nkene munamana kutera suka kufikako nonguwo (blanket) ndi sipereki (zinc sheet);*
- *Kuvisuva virare mayuva maviri ndi matau nkene vinapi (fermented) ntani ngoli ngomu kavitura mundoroma yokukendjera (cooking drum)*
- *Makura kuvareka ngoli kukendja.*

RT: How do we do it:

- you take mangetti fruits (*ngongo*) and put in the metal cooking drum;
- then you add in water and put it on the fire to let it boil;

Figure 5.3 (b) A woman preparing by putting on a fire to boil mangetti fruit. ***Mukamali ana kukuwapayikiro a hamekeko mundiro mposi atereke ngongo***

- when it turn reddish brown colour, stop boiling;
- then take it out and put it on the ground;
- then you take a pestle (*muntje*) and mortar (*sinu*) to start pounding;

Figure 5.3 (c) Showing a mortar *(sinu)* and pestle *(muntje).*

Mortar *(sinu)* Pestle *(muntje)*

- After pounding you put it on the zinc sheet *(sipereki*) and start picking out hard nut-like seeds;
- then you put these seeds (*yigongotji*) aside separately;

Figure 5.3 (d) Hard nut-like seeds of mangetti fruit *(vigongotji)*

- Then mixtures of outer skin and flesh *(ghutumpi*) is poured into the metal drum *(ndoroma*);

- Then you put the water in the drum with hard nut-like seeds and pound it with a pestle (*muntje*);
- And then you take the water used with the hard nut-like seeds and put in a drum with the mixture (*utura*) and stir it together;
- Take sugar and add on the stirred contents of mixture and stir it again then cover it with old blankets or zinc sheet;

Figure 5.3 (e) A woman covering contents or mixtures in a metal drum with zinc sheets and putting on stones for support and leaving it for at least two days. *Mukamali kunakufikako ku ndoroma yokukurungira navipereki kunakuturapo mawe avisuve vikare mayuva maviri.*

- Leave it about two to three days for it to get ready (fermented) and once it is fermented it is called v*itapwira;*

Figure 5.3 (f) Metal drum with mixed contents/mixtures fermenting. *(Ndoroma yokurungira novitapwira vinakuviro)*

- Then you can put it in the boiling metal drum and put it on the fire to start the distillation process.

The following are the figures representing some steps during the distillation process of *Kashipembe* at a community member's work place *(siterekero).*

Figure 5.3 (g) Condenser (*muyengo)* and boiling metal drum (*ndoroma yokuterekera)*.

Figure 5.3 (h) Boiling metal drum covered with zinc sheet and mud, distillation process of *Kashipembe* taking place. (*Ndoroma vana turako sipereki nokuyiramba nosighuru kunakukendja Kashipembe).*

Figure 5.3 (i) Collecting alcohol *Kashipembe* in a cut can container through the condenser and putting it in a bottle. *(Kuna kughupako marovhu gha Kashipembe musitoromani kupitira mumuyengo makura kugha tura mulikende.*

IQ.3: Ya kughupako vinya. Lipuro lyoghutatu. Vighamba munke mwayuvha ko vyokuhamena Kashipembe? Turenke tupusi shihoninito yira kumukuro.Asi nkene ghuna karapanyama kwato kuyenda kumukuro nevisi ngakakukwata mvhuu. Kukasipembe ngoli kwato vyo mwayivako vyokufana ngoli.

RT: Ok. Apart from that, the third question. What kind of story is there about *Kashipembe*? Taking an example of the river. They said if you had sexual intercourse you should not go to the river as you might be attacked by a Hippopotamus. Do you know anything like that with *Kashipembe*?

CMR: Navyo mpovili vyokurenkasi nkene murume nomukadi anakasondera ayepo kuhura virukure. Asi malyata mpadi makura avirukura. Hambara ndimbyo vya kararopo tupu mbyovyo.

RT: Yes, we have the belief that if a woman or a man had sexual intercourse and comes to where they are making *Kashipembe* the contents or mixture will come out from the condenser instead of *Kashipembe* itself. Because it is a kind of a taboo then it will not be successful. That is what we have as a belief. These stories are a way to enhance the learners' enjoyment of Physical Science.

FQ: Ya, kanimonanga pakare nkene munali makura muyepo kumurenka asi likusenu unene kumawoko, ovinyane vinke kavaviruwanenanga?

RT : Ok, I used to see in the past if you have just finished eating they will tell you to wash your hands thoroughly, why was it like that?

CMR : Yi, morwamungwa. Nkene muntu anakwatakwata vininke vyomungwa ayakwateko makura vyakona kudjonauka vene. Makura pakukavi kendja mema-mema. Mungwa nokasipembe kapi vyali sana, mpili apite mara kukara mema-mema kwato nka ururu.

RT : Yes, because of salt. If a person touches salty substances and touches the contents or mixtures of *Kashipembe* it will be spoiled. When you do that, it will be tasteless. Salt and *Kashipembe* are not on good terms, even if *Kashipembe* comes out but still there will be no alcoholic concentration in it.

IQ.4: Walye viruwanita munke mwa hepa mposi muruwane Kashipembe?

RT : What materials do you need in order for you to make *Kashipembe*?

CMR : Evi twaruwanitanga Kashipembe. Ndoroma yokuterekera, ligarona lyokukoshera (ndi ndoroma vatenga) ntani muyengo ndi mbyo twaruwanitanga unene pakukendja Kashipembe.

RT : What we use to make *Kashipembe*. Cooking metal drum, big container for mixing (even metal drum which is cut open at the top of it) (*ndoroma*) and a condenser (*muyengo*) these are what we use most when making *Kashipembe*.

Figure 5.3 (j) Boiling metal drum *(ndoroma yokuterekera)*

Figure 5.3 (k) Condenser *(muyengo)*

IQ.5: Walye oghu Kashipembe varenani ava vafero kumuruwana vakamali ndi varume? Tutureko nokonda tupu.

RT: Who is supposed to make *Kashipembe*, males or females? Give reasons.

CMR : Ya, yiramu mwetu unene ndi mbovo vakadi vene mbovaviruwanango. Konda ndjeyisi atwe vakamali twe tupu twakaro noudito muliparu mbyo twarenkeranga tupu kehe ruvede tu kendje Kashipembe tukuvatiliteko mulipata.

RT: Ok, like here mostly ladies are the ones making *Kashipembe*. Because we ladies are the ones who have to make a living, that is why we always make *Kashipembe* so that we can use [the profits] to support our families.

IQ.6: Walye mayuvamangapi aghupanga Kashipembe ntani vakamukenga. Kuvarekera tupu pakumanakumurunga vitwaretupu kumeho dogoro kukakendja?

RT : How many days does *Kashipembe* need before it is ready to be made? Just starting from the mixing of contents until the day of the distillation process.

CMR : Ruvede rokurenkasi namuntji ghuna virungu dogo ngokakendje, ngogho mayuva maviri vene. Kuvhura tuvirunge namuntji weno Mandaha, yona Uvili viyusare muUtatu ndi kukendja. Kuvhura ghararemo mayuva maviri ndi matatu kare anapu nka kumughura. Kasipembe ndando zongwa sili, azokugenda nawa ntani kuvhena mosili.

RT: The period from today when it is prepared until you carry out the distillation process. It takes only two days. We can mix it today Monday, and tomorrow Tuesday allow it to stay there to ferment, then Wednesday we can start distilling. It might only take two to three days to be finished buying it. *Kasipembe* is a good business and again it is profitable.

FQ :Vinke uvhurakuruwanako mposi vikwangure kuvira ?

RT : What can you do so that it can ferment fast ?

CMR : Aye, kwato. Mara omu twaruwananga kusuvidamo vitapwira vimwe muligarona ndi mundoroma. Makura ovyo vitapwira mbyo uwedererako makura kukwangura kuvira. Nkene patini unaviturako apa yika toona vili yaghu ntambiri kungurova vinatameke kare kuvira. Ovyo vitapwira mbyo ngoli hingo yako.

RT: No, there nothing you can do. But, what we used to do is to leave out some of the contents (*vitapwira*) in the mixing container or drum. Then, the left over (*vitapwira*) is what you will add to make it ferments faster. The left over (*vitapwira*) acts as the yeast.

Figure 5.3 (l) Covered contents in metal drum to be left for two days (*Vanavifike vitapwira vavisuve mayuva mavili)*

IQ.7: Nkene muna mana kukendja Kashipembe, vare vafero ngoli kumunwa?

RT: When you are done making *Kashipembe* who is supposed to drink it?

CMR: Ndi vene-vene vanya vokurenkasi pakatji tupu kapisi musamane ndi mwanuke aye pakatji tupu vanya vokurenkasi rutu simpe ruwawa. Vasamane kapi vana kunwa nka nawa-

nawa Kashipembe morwa marutu ghana roroka. Morwa Kasipembe nkondo unene nokuvhurasi kumunwa vanuke. Viruwo vimwe vanya vanwango Kashipembe kuwawa kene kapi kali yona, makura evinavyo kurenkita vanuke vakare nowoma asi nevisi vakawawa navo morwa Kashipembe.

RT: People who are supposed to drink *Kashipembe* are those who are not too young or too old but just in the middle age. Just for those people who are healthy and physically fit is better. Old men and women are not drinking *Kashipembe* nowadays because they are ageing now. Only young men and women who are drinking *Kashipembe.* This happens because *Kashipembe* is regarded as one of the strongest alcohol. When some people drink it on an empty stomach it causes dizziness and tiredness and even falling. When young ones see all these effects they tend to be afraid and make them not to drink it.

IQ.8: Omo mwavimonangako ngoli nwe, vidonandi viwa kukendja Kashipembe umughulite mumukunda?

RT: How do you view the making of *Kashipembe*, is it good to make and sell it in the community?

CMR: Mwene-mwene kapisi mudona kaya muwa. Omo twamurenkanga pamwe novaruyenda ndjira kumunwa. Kapitwarenkanga asi ndi vamunwe mbava vomumukunda tupu. Kapi ayitanga maudito vene muwawa tupu. Udona tupu ngogowosi nkene mumntu kumunwa kukorwa. Morwa nkene muntu anakorwa awe ruvede rokufu kuvhura kufera mundjira. Ano uwa ne ngowo vene wokuwanenamo viyeramo.

RT: Actually, *Kashipembe* is not that bad. Because we make it so that even visitors should drink it not necessarily the villagers only. *Kashipembe* does not bring problems it is just ok. The only bad part is that when a person is drunk and fall on the road night time during winter, the person might die there. This is one of the problems *Kashipembe* brings. But the good part of it is that you are earning profit from *Kashipembe*.

IQ.9: Vinke vatuliranga ko suka kuvirungarunga vyaKashipembe?

RT: Why do people add sugar to the mixtures or contents of making *Kashipembe*?

CMR: Morwa kurenkera edi mwaka twakuyayenda weno ngongo kapidakuwana nawa mema makura kwato utovara. Makura mbyo twarenkanga tutureko suka mposi avhuke Kashipembe. Ntani kurenkerasi Kasipembe akare nonkondo. Nkene kuruwanita ntjako yongongo yo 25 kg ntani neyiyo suka yo 25kg, kuyura ndini ya litera 25 (25l) yoKashipembe. Ano nkene kwato suka kuwanako yimwe tupu yalitera ntano 5. Nkene otwikire asi ghughupeko litera rombiri nantano, ururu kupwamo woKasipembe makura kukwamako Matjatja.

RT: Sugar, because like nowadays mangetti fruits (*ngongo*) is not getting enough water and it is losing its taste. That is why we use sugar to obtain more *Kashipembe*. And also, to make it tasty for *Kashipembe* to be strong in alcoholic concentration. Example if you use 25 kg of mangeti fruits and you add on 25kg of brown sugar, you will obtain 25 litres full of *Kashipembe*. But if you did not use sugar on 25 kg of mangetti fruits, you will only get 5 litres of *Kashipembe*. And if you continue to obtain some more, less concentrated *Kashipembe* will come out, we call it *Matjatja* and your *Kashipembe* will not be alcoholic enough.

Brief analysis of the above data derived from the interview with a community member

The interview with a community member yielded more data on this process. This interview attempted to find answers to how the teaching of distillation could be improved by incorporating the demonstration on making *Kashipembe.* The community member removed the misconceptions of some learners with regard to making *Kashipembe* which is the process of distillation. The way she discouraged some of the practices can be useful to teachers as they can also use her skills and copy the process with their learners in the classroom. She was able to highlight the good part of *Kashipembe* as it is one of the profitable businesses which is why women do it to support their families (see IQ.8 above). The interview showed that it is important to incorporate the traditional demonstration of making alcoholic brew. This knowledge can be used to improve the teaching of the topic distillation in the classroom. The community member did not take sides and defend her business but she was straight forward with the facts and her experience about making the alcohol. She confidently expressed her ideas whenever asked a question. These ideas could be used in the science classroom to teaching and learning activities.

Sugar is added to the mixture in order to obtain more *Kashipembe.* This was a practical move because sugar acts as a catalyst for fermenting the mixtures in order to yield more alcohol.

Despite the benefits of this alcohol, she stated that the bad part of *Kashipembe* is the drunkenness. She emphasised that one needs to eat food before imbibing the alcohol. The teachers can use this knowledge to improve their teaching and to educate their learners about the side effects of alcohol.

When I asked her about whether any studies were carried out which involved a community member, she said no. She did attend community meetings with agricultural officials when it was time to start ploughing. She expressed that the people in the community know a lot which teachers can use and link to school science. For example, she suggested that teachers could use the villagers who know how to beat drums and do cultural dancing to involve the learners.

The community member was very happy with the interview, and especially with seeing herself in the video.

5.4 Data from semi-structured interview with the learners

Initially, this particular follow-up interview with the learners was originally intended to merely check on what the learners had learnt from the community member, that is, field experience in conjunction with classroom experience. It struck me during the process that this agenda was too narrow and should be expanded for learners to speak directly about how teacher should make sense of distillation. In a real sense this interview with the learners was twofold, namely, sense making of the topic distillation and improving the teaching of the topic distillation.

IQ.1: Do you think science teachers should consider learners' prior everyday knowledge when they are teaching distillation?

L1: *Yes prior knowledge is important. For instance like the presented topic of yesterday. The teachers have to ask question to find out if the learners knows something about the topic before introducing the new topic. And if the teacher is continuing with the previous topic he or she should revise the covered topic to see if learners understood the topic or not. To find out if they have really acquired skills and kept it in mind about the topic.*

L2: *It is very important for the teachers to consider the prior knowledge of the learners in a class. Because, when we talk of Physical Science is like a combined of knowledge* *from school and the communities which need to be used and come up with solid solution. And this will make the learners to understand the topic like distillation.*

L3: *It is very importance because it will make the teacher aware of the people he is working with and what he is going to talk about. Just like distillation if they know what use to happen at home they will bring that at school and make a teacher to relate it to the main topic. Taking examples of experiments on distillation, if there is a person who did it already it is easier to make other understand it also. This helps the teacher to know where to start.*

L4: *It makes the work of the teacher easier. As the one who knows something about the topic will be able to lead the topic and make the lesson to flow. Because the learner might do about the topic at home or previous grade then it is easy for other to follow. This will automatically save time of the teacher by not explaining more and more repeating the same topic.*

IQ.2: Do you think it is importance to involve a community member in the learning of science (distillation) at school? Like the way we are doing it now with the woman who is preparing *Kashipembe*.

L1: *It is very importance because the community member might know something which we do not know. So, by involving that person he or she will teach us those things which we do not only then we learn it from him/her. And will show us that this you do it like this and that you do it like that its better.*

L2: *Yes they are needed. For instance in school we use beakers but in the community they can use other container to substitute a beaker. As this community member is showing us all this, we are exploring and knowing a lot about the materials used to carry out distillation in the absence of scientific materials.*

L3: *It is very important. Because a teacher will teach and learners will not understand what the teacher is teaching. But when that community member will explains it in our vernaculars' we learners will understand it better. Really it very important to involve the community members in the teaching of science topic like distillation.*

L4: *It is very important because some learners do not understand English used. So, when they will explore in their vernaculars they easily know that this is called a beaker, a horse pipe or others. Because even if you know things in English and you do not know them in your language it is a problem and you might not progress.*

IQ.3: Looking at the topic presented, do you think it helped all the learners or just the few of the learners?

L1: *To me it just helps some few individuals. Because, some of the learners who did it or knows the things already it helped them and understood the topic. While for other learners did not understand it as it was only for drawing did not see reality.*

L2: *The topic help and it is important to learners. Some might not see its importance but they might need it in the future. Especially, when the time of parties you might be told to make Kashipembe or vinegar. Then you will recall with what you have been taught at school then it might be helpful. I can say whatever they teach in the class is all useful.*

L3: *In addition to that, it was important to everybody in the class. Because even myself I did not know how distillation process works, but after that presentation I could catch up with the topic. And now I know that these things are done in this way.*

L4: *Yes, it was helpful. The drawing sometimes is helpful because the more you are drawing the more you know it and you will be able to connect it yourself if they are given to you. If you do not know how to draw it will not help you, you will just see the picture there but you do not know how to connect it. This might lead to you to wrongly connect the apparatus in their right position on the figure.*

IQ.4: How do you view practical work in Physical Science on the topic distillation?

L1: *Practical's are helpful in school. As things which you do by touching is easier to remember it. Yes, you can study by figure on papers but still practical's are just the best as you will be hands-on doing the work. Practical's helps learners to remember the work even when asked in examination. Practical is very important.*

L2: *Practicals are very important in science because when a learner will work with those equipments he will not forget. Because when the learner is going to write exam he or she will remember how it was used and will be able to give correct answers. For example the use of the thermometer, the learner will remember it easily because the thermometer was used during the experiment.*

L3: *Practical helps us to understand things more, the more you do it is the more you understand it and that is the more they are becoming easier. Because if you just see it, it is not enough. Like thermometer you just see it and know its function but you do not know how you can read it and take the temperature. If you do not know how to use it you might fail it in examination.*

L4: *In general practical's. Let's say you used the equipments at school during practical, when you reach at home somebody might ask you the uses of a certain apparatus. Then, it is easy to tell the person all the uses you gained from the practical. In other words we need action not just talk there and leave.*

IQ.5: How do you feel about being a participant in this study?

L1: *I feel very happy because the study is helping me. Even maybe in future I will do the same work I know what the basic procedures to be follow. I will be able to follow it as it was given to us and I have learned how to approach learners to negotiate just like how you did it to us.*

L2: *I am also happy to be a participant in this study. It helped me to know how this process is being carried out and to relate it to school science. Being a member also gave me ideas on how I can assist other learners to partake in research like this one. Because in class we only talk about investigation and we do not go out and experience it in the society instead they just write it down. During this research for us we went in the community and discuss with the community member and find out. And now even when you present it to your teacher he will also be surprised because some they do not do it correctly they just write and submit. With this I mean some they just sit in their houses and write everything. And now even us we will follow what you did when we will reach there to produce good report.*

L3: *To me is like this research should continue like that, because it really inspired me and be interested in the topic distillation. I am able to connect it with what we learn in school. There some terms which I did not know but now I know them I am proud to* *involve in this research as a whole. Now I know much better about distillation then previous years of my studies.*

A brief analysis of the above data derived from the interview with the learners

The main idea behind this follow-up interview with the learners was to understand how the Grade 11 Physical Science teachers could improve their teaching of the topic distillation taking into account the views of the learners. The learners outlined that teachers should first find out what learners know about the topic before he or she goes in detail (see Section 2.6). Prior knowledge also makes the teacher aware of their learners' background knowledge on the specific topic and this gives direction on how to teach the topic effectively.

IQ1.L2, above said the following:

> *"It is very important for the teachers to consider the prior knowledge of the learners in a class. Because, when we talk of Physical Science is like a combined of knowledge from school and the community practices which need to be used and come up with solid solution. And this will make the learners to understand the topic like distillation".*

Moreover, the learners supported the idea of involving the community member in the learning of science. The learners in this study stated that sometimes community members can teach both learners and teachers something. Similarly, learners and teachers could also do the same for the community members. That is, this could be of mutual benefit. Interaction with the community could build a strong bond between the school and the community. Furthermore, this interaction and integration of knowledge could help the science teachers develop good teaching strategies which would enable learners to grasp the topic distillation. The support of the parents would make teaching even more effective as the more involved they are in the education of their children the better for everyone.

The following was said by learner two above*: IQ.2.L2: Yes they are needed. For instance in school we use beakers but in the community they can use other containers or cut cans to substitute a beaker. As this community member were showing us all this, we were exploring and knowing a lot about the materials used to carry out distillation in the absence of scientific materials.* The teachers can make use of this knowledge of substituting apparatus to teach the scientific concepts with readily available materials within the community. This interrelationship of schools and community can create a good teaching and learning atmosphere in the school in collaboration with the community.

Practical activities are very important in science subjects. The learners maintained that practical topics like distillation need to be studied while carrying out distillation practically. IQ.4.L1 above states that practical's are helpful in school. *As things which you do by touching is easier to remember it. Yes, you can study by figures on papers but still practical's are just the best as you will be hands-on doing the work. Practical's helps learners to remember the work even when asked in examination. Practical is very important.* The time spent on preparing and doing the demonstration by the community member serves as an example to the teachers about how to prepare for practicals in advance, which would improve the teaching of distillation.

I now discuss the model lesson which was developed to enhance co-learning of the topic distillation.

5.5 Development of a model lesson together with two Grade 11 Physical Science teachers

The model lesson was developed using the latest Namibian syllabus of Physical Science 2010 Grade 11-12 using a learner-centred approach. The intention was to develop two model lessons but due to the teachers' busy schedules which were beyond their control we only managed to develop one. This lesson includes some strategies such as learning and teaching support materials (LTSMs) on distillation, introduction of the topic on distillation (prior everyday knowledge of learners) and content on the topic distillation. Furthermore, suggestions on practical activities are stated and described.

The model lesson was planned to be used by teachers teaching in schools with limited resources to carry out distillation in school laboratories (see Appendix J (i)). The model lesson also contained a list of definitions of concepts and functions of some apparatus used in the topic distillation. It was hoped that the model lesson would facilitate co-learning pertaining to teaching strategies through the discussions and reflections.

5.6 Concluding remarks

In this chapter, I presented the data obtained from the brainstorming session on distillation with learners on making *Kashipembe*, data from a semi-structured interview with a community member on making *Kashipembe,* data from a semi-structured interview with the learners and the development of two model lessons working together with two grade 11 Physical Science teachers. My conclusion is that the use of learners' prior everyday knowledge and the involvement of a community member in my study made a big difference in the learners' ability to make sense of the concepts in distillation. In the next chapter I present and discuss the analysed data in relation to the literature reviewed in Chapter 2 of my study.

CHAPTER SIX: DATA ANALYSIS AND DISCUSSION

> *Data analysis involves organising, accounting for and explaining the data. This is all about making sense of the data in terms of participants' definitions of situation, noting patterns, themes, categories and regularities. This is best achieved through a process of inductive analysis of qualitative data where the main purpose is to allow research findings to emerge from the significant themes inherent in raw data (Maree, 2012: 99).*

6.1 Introduction

This chapter highlights the analysis, interpretation and discussion of the data that were gathered and presented in Chapters 4 and 5. As the epigraph indicates, for analysis purposes, I developed analytic statements from the emergent themes in relation to the data sources as well as the research questions described in Section 3.3. In my discussions I also link the findings to the literature reviewed in Chapter 2. I also highlight the techniques that I used to obtain answers to the following research questions (see Section 3.6):

- In what ways do grade 11 Physical Science teachers help learners make sense of the related concepts when teaching the topic distillation?
- What factors enable or constrain learners from making sense of such concepts on the topic distillation?
- In what ways can grade 11 Physical Science teachers improve their teaching strategies when teaching the topic distillation?

In this chapter, I explain how my themes were developed from the data I presented in Chapters 4 and 5. I also include the interpretation and discussion of findings based on my themes and my findings are used to discuss the teaching of the topic distillation. This chapter ends with some concluding remarks.

6.2 A short structure on how the themes were developed in this case study

During my data gathering process, I used qualitative data analysis. The qualitative analysis gave rise to themes that emerged from the data inductively. After the transcriptions of all the analysed documents, videotaped data, learners' written work, and demonstration of making *Kashipembe,* I came up with a total of 10 broad themes. When I looked at the themes in detail, it was clear that some themes were infrequent and others could be combined. Hence I reduced them to only six themes. I illustrate these in the table below.

Table 6.2 (a) The original 10 themes that emerged from the data

Total number of themes	Emerged themes
1	Analogies
2.	Learning and teaching support materials (LTSM)
3.	Code-switching
4.	English language and scientific concepts
5.	Learners prior everyday knowledge (PEK)
6.	Indigenous knowledge (IK)
7.	Practical work (PW)
8.	Teaching strategies
9.	Sense making of the topic distillation
10	Active learners engagement

Table 6.2 (b) The reduced six themes which emerged from the data

Total numbers of themes	Emerged themes
1	Teaching strategies
2	Practical work (PW)
3	Learning and teaching support materials (LTSM)
4	Learners' prior everyday knowledge (PEK)
5	Indigenous knowledge (IK)
6	Active learners' engagement

The themes that emerged from the analysed data were further arranged into analytic statements that were compared to the degree to which the data supported the statements.

Table 6.2 (c) Table of research question, data source used in the study, themes, analytic statements

Research questions	**Data source used in the study**	**Themes**	**Analytic statement**
• In what ways do grade 11 Physical Science teachers help learners make sense of the related concepts when teaching the topic? • What factors enable or constrain learners from making sense of such concepts on the topic? • In what ways can grade 11 Physical Science teachers improve their teaching strategies when teaching the topic distillation?	Documents, observations, interviews, notes and test. Brainstorming, discussions, interviews, demonstration of making *Kashipembe*, two model lessons and reflections	• Teaching strategies • Practical work (PW). • Learning and teaching support materials (LTSM). • Learners' prior everyday knowledge (PEK). • Active learner's engagement • Indigenous knowledge (IK).	• Making use of appropriate teaching strategies when teaching topic distillation. • Use of practical work to make sense of the topic distillation • Using learning and teaching support materials (LTSMs) to make sense of scientific concepts related to distillation • Eliciting learners' prior everyday knowledge (PEK) during teaching and learning distillation. • Learners' active engagement during teaching and learning of topic distillation. • Using indigenous knowledge (IK) and community practices to make sense of scientific concepts.

The following section discusses the analytic statements that emerged from the data as indicated in Table 6.2 (c).

6.3 Analytic Statement 1: Making use of appropriate teaching strategies when teaching the topic distillation

Throughout the analysis of my findings I noticed that both teachers attempted to some degree to use a learner-centred approach through the use of the question and answer method, group work and individual activities as strategies to make sense of the topic distillation.

Learner-centred education is supposed to foster successful learning for all learners by taking each other's existing knowledge, skills interests and understanding- derived from their previous experiences in and out of school (Nyambe, 2008).

Mr. Strong mentioned in the interview that he always used a learner-centred approach when teaching (see Appendix H (i) IQ.4). But this was not evident when I observed his lessons.. He sometimes used more teacher talk (see Appendix H (v)). Mr. Strong also spent a fair amount of time using a typical learner-centred approach when learners were doing group work. On the other hand, Mr. Gaps claimed he used a learner-centred approach and he also grouped learners during an informal discussion in the classroom. Thus, these teaching strategies helped learners to be more involved which, according to the research, helped them to make sense of the topic distillation.

As mentioned earlier, group work and individual work were also used as teaching strategies which enhanced the conceptual development of the learners (Keith, Pritchard & Roesch, 2006). A good example is the quiz activity carried out during one of the lessons (see Appendix H (v)). Likewise, Mr. Gaps started with group work as an introduction to the topic after which he sent the learners to go and read about the concepts and report back to class (see Appendix H (vi)). The process of writing the activity in groups and individually together with discussion helped learners to understand the concepts on distillation (Vilaythong, 2011).

The main teaching strategies observed were the question and answer method. Both teachers used this as the core strategy when they were discussing learning content in the classroom (see Appendices H (v) and (vi)). Mr. Strong posed more closed-questions than open-ended questions in the form of "what" and "why" questions, while Mr. Gaps frequently used both closed and open-ended questions of "explain", "describe" and "why" which at least made learners think independently. During the teaching of the lessons both teachers used some everyday life examples from home or community to relate them to the distillation process (see Appendix H (vi)). These goes hand in hand with the Namibian subject policy of Physical Science (2008) in Section 2.3, were it states that teachers should be creative at all times by using different teaching styles to make meaningful teaching and learning.

This linkage of community experiences (Rennie, 2011) helped learners to make sense of the concepts related to distillation. Both teachers introduced learners to the traditional beverage commonly made by people in Kavango East and West region which is known as *Kashipembe,* even though the way they introduced it differed. This revealed that teachers have the idea about the use of teaching strategies by incorporating community knowledge in various science topics like distillation. However, teachers might not have enough time to do it during normal school days as they have to ensure that by the end of a specified period the syllabus is completed. The findings of this study show that this inclusion of community experience through learners' prior everyday knowledge helped learners to grasp the contents of concepts related to distillation (Ausubel, 1986).

6.4 Analytic Statement 2: Use of practical work to make sense of the topic distillation

The findings indicated that the teachers gave some activities to the learners to do, both written tasks in books or on the chalkboard and oral activities as stated by the policy documents. However, even though the activities attempted to make sense of the topic distillation, they were not insufficient for conceptual understanding of a practical topic like distillation. the cause of practical activities was the unavailability of fractionating column, thermometer, condenser and other apparatus. For effective teaching and learning the learners also need to see, touch, observe and feel the science inside or outside the classroom, therefore all learners should be exposed to practical activities as a minimum requirement (Namibian Physical Science Subject Policy, 2009). The teacher should do adequate hands-on practical activities in order to make the topic distillation more understandable to learners. Learners should feel that they have freedom to direct and adapt the activities according to the questions which emerge from their own experiences. This encourages them at various stages of the inquiry to "predict, explain, explore, observe and explain (PEEOE)" their action as it is proposed by Maselwa and Ngcoza (2003).

This study also looked at the use of community practices to make practical sense of the topic of distillation. According to the learners' responses in interviews about practical work, it was revealed that practical work which is hands-on activities helped the learners to understand and remember the contents of the topic (see Section 5.4, IQ.4.L1-L4). This was supported by the literature where it is stated that; scientists believe that learners should learn by doing what scientists do that is when we can educate future leaders (Klainin, 1995). For that reason, the findings of this research show that practical activities can help learners to make sense of scientific concepts including distillation.

6.5 Analytic Statement 3: Using teaching and learning support materials (LTSMs) to make sense of scientific concepts related to distillation

Learning and teaching support materials (LTSMs) are materials which are used during the teaching and learning process, which include: charts, audios, textbooks, chalkboard, projectors, posters and *etcetera*. This is strengthened by Czerniewicz, et al., 2000 who explained that LTSMs are prepared materials which structure and support learning and teaching. Observation of the lessons showed me that teachers used charts and chalkboard during their teaching of the topic distillation. The views expressed here concur with the Namibian Physical Science Subject Policy (2009) where it states that Physical Science teachers should be creative and innovative to produce their own teaching and learning materials linked to practice.

The use of charts by Mr. Gaps as learning and teaching support material helped the learners to make sense of the topic distillation. Mr. Gaps supported this where he stated that the learners grasp the ideas by studying and identifying the figures of the two distillation processes. This is supported by the literature where Haury and Rillero (1994) accredited that learners using LTSMs during science lessons remember the material better, feel a sense of completion when the task is concluded, and are able to transmit that experience more easily to other learning situations.

The chalkboard was one of the LTSM used during the lessons. Both teachers used the chalkboard correctly by drawing figures and writing on it. This assisted the learners to get the right information and helped to make sense of simple and fractional distillation. The use of the chalkboard by the learners was a good strategy as the learners came to the front of the class and were actively involved in the lesson.

The other LTSMs used during the study were textbooks. The findings show that textbooks formed the base line of the study in terms of learning and teaching support materials. It was clear that the distillation contents covered in the analysed textbooks were in line with the required basic competencies in the Namibian Physical Science syllabus 2010. The addition of figures showing the apparatus needed for carrying out distillation processes was useful. So much so that we used the textbook and syllabus to come up with the unit of work (see Appendix G (i)). Most of the content delivered by the two Physical Science teachers was from these textbooks. After marking the test it was revealed that most of the learners passed the test. This is an indication that the textbooks as LTSMs were used correctly and why the learners understood the topic distillation and achieved good marks in the tests.

Moreover, Mdlungu (2006) indicates that the capability to construct knowledge informs the teacher of possible approaches and how LTSMs can be used in teaching and learning. The brainstorming session and community members' demonstration of making a traditional brew also made use of materials which were integrated with the apparatus used in distillation (see Section 5.2, IQ.1-IQ.9 and 5.3, IQ.1-IQ.9). The finding revealed that learners realised that materials used in science can be substituted with materials found in the local environment or community (see Section 5.2. IQ.3. L1-L11). These sessions helped them to learn the names of scientific apparatus in both the official language English and the vernacular Rumanyo (see Section 5.2, IQ.1 and IQ.2). These findings indicate that using community knowledge and experience in teaching science concepts helped learners to understand the topic distillation.

6.6 Analytic Statement 4: Eliciting learners' prior everyday knowledge (PEK) during teaching and learning distillation

During the interviews and lesson presentation it was clear that both teachers used their learners' prior everyday knowledge (NCBE, 2010) to teach the topic distillation. The findings of this study also indicate that prior knowledge of learners is important in helping teachers to build on learners' understanding to make sense of the conceptual topics like distillation.

Distillation was taught by both teachers with reference to the alcoholic beverage made by Kavango people called *Kashipembe*. Then learners were asked to give their experiences and knowledge on this traditional brew which elicited the prior everyday knowledge which they have (Meyer, 2004). The findings indicate that learners know a lot about the community of practice activities which are related to science. Therefore, teachers should use this knowledge to connect it with what is learned to make teaching of the topic distillation meaningful and to open their eyes to the fact that science is everywhere.

The study revealed that *Kashipembe* is made in the same manner in the Kavango East and West regions. It is made from various types of fruits depending on their availability. The community member maintained that all the fruits could be used but the most common nowadays are money orange (*maguni*) and mangetti (*ngongo*).

The study revealed that most of the apparatus can be substituted with the local available materials to carry out the distillation process. The finding further indicate that the process of making *Kashipembe* helped learners to make sense of the topic distillation in the classroom as they can now describe the distillation process in class. The theory of fractional distillation for separating liquids with different boiling point may also be related to the making of *Kashipembe.* Because during the distillation process first alcohol *Kashipembe* is collected than later *matjatja* which is water-like or tasteless liquid comes last, the same happens to ethanol and water.

During brainstorming and the interview it was revealed that one of the benefits of *Kashipembe* is the generation of income mostly by woman as they are the ones responsible for the family. The learners support the idea that *Kashipembe* has a role to play both economically and socially in that it brings the people together.

The downside is that the brew causes drunkenness with its subsequent bad effects. The theory behind the explosion of *Kashipembe* when you pour it on glowing charcoal or splint and the alcoholic contained in it remains unknown. My intention was to find the alcoholic percentage but things did not go according to plan.

6.7 Analytic Statement 5: Learners' active engagement during teaching and learning of the topic distillation

During the lesson observations in the classroom, learners were actively involved in the lesson by answering the questions posed by their teachers during the discussion. The study shows that when learners were actively engaged in the lesson activities it helped them to master the content on distillation. Jegede (1995) explained that depending on the content, experience and the social context, learners sometimes engage in 'border crossing' that retains both the cultural and science knowledge, thus engaging them in the processes of collateral learning.

I observed that learners were actively involved during the oral activities and that of labelling parts of the distillation apparatus on the chalkboard. The findings further show that learners were lively when they had a platform to use learning and teaching support materials during the teaching and learning process. This teacher-learner interaction helped learners to handle scientific apparatus during practical activities (Vilaythong, 2011) which enhanced the understanding of topics like distillation. Learners were also active during the brainstorming session on the making of *Kashipembe*. This could be attributed to the fact that they have prior knowledge on the topic (Stears, Malcolm & Kowlas, 2003) which aided their understanding of the topic.

6.8 Analytic Statement 6: Using indigenous knowledge (IK) and community practices help to make sense of scientific concepts

Throughout the investigation I realised that there is a lot of useful indigenous knowledge and practices that are hidden in the community which could be used more fruitfully in science learning, such as the making of *Kashipembe* (Rennie, 2011). As per the data gathered through semi-structured interview with the community member at her home it was clear that people in the communities are eager to see how their children are progressing academically in schools. The findings indicate that the knowledge and skills acquired through the demonstration by the community member could be used by teachers to improve the teaching of the topic distillation.

During the practical demonstration of making *Kashipembe* by the community member and brainstorming session with learners it was revealed that there are specific scientific knowledge embedded in the making of *Kashipembe* even though it is not recognised by the educators and the Ministry of Education. This could be due to fact that the Namibian curriculum and syllabus were inflexible in the past and did not inspire teachers to be creative and innovative during their teaching by including indigenous knowledge in their teaching (Van Wyk, 2002). Learners gained a lot of knowledge from the process of *Kashipembe* which they connected to the concepts related to distillation

6.9 Concluding remarks

This chapter provided some interpretation and discussion of the data presented in Chapters 4 and 5 in relation to the literature reviewed in Chapter 2. Insights were captured and reported according to analytic statements and each was discussed in detail. The next chapter provides a summary of the findings, makes recommendations and suggests some areas for future research. Finally, a conclusion and my personal reflections on this journey are recorded.

CHAPTER SEVEN: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

The summary will identify the key factors, key issues, key concepts and key areas for subsequent investigation. It is a watershed stage during the data collection, as it pinpoints major themes, issues and problems that have arisen, so far, from the data and suggest avenues for further investigation (Cohen, Manion & Morrison, 2011: 568).

7.1 Introduction

In the previous chapter I analysed, interpreted and discussed the findings of the data presented in Chapters 4 and 5. In this chapter I present a summary of the research findings, recommendations, and areas for future research, research limitations and conclusion of the study. Lastly, my personal reflections on this journey are provided in the form of an epilogue.

7.2 Summary of findings

The main goal of this study was to understand how Grade 11 Physical Science teachers mediate learning of the topic distillation.

The findings indicate that both teachers attempted to practice a learner-centred approach during their teaching of the topic distillation. However, the intention of using learner-centred approach was only partially fulfilled. The study revealed that both teachers used the question and answer method, group work and activities to help the learners grasp the lesson content on distillation. The teachers' usage of different teaching strategies is important in the classroom where a learner-centred approach is being practiced to strive towards learning the concepts related to distillation with understanding (Nyambe, 2008).

Additionally, it was clear that the use of everyday life examples by both teachers and learners during the presented lessons helped the learners to make sense of the topic experimental techniques which includes distillation (see Appendix H (vi)). Oloruntegbe and Ikpe (2011) support the idea that everyday activities make learners aware of the importance of science which in turn helps them to understand key ideas in science. The integration of *Kashipembe* made in the Kavango regions by teachers during the lessons showed that some teachers do incorporate learners' knowledge and experiences during teaching to make sense of the topic distillation. The making of *Kashipembe* which was conducted by the community member improved the teaching of the topic distillation by the two teachers. The use of everyday knowledge in the classroom increases the levels of engagement of learners, and the learners' enjoy making connections between different experiences which facilitates learning (Stears, et al., 2003)

The use of practical activities when teaching the topic distillation was also raised by both the teachers and learners who were involved in this study. The findings of my study showed that practical activities help learners to be hands-on and enhances their participation during the lesson and this is supported by Maselwa and Ngcoza (2003). When the learners are more involved in practical work where they can use and observe real life substances they make more sense of the concepts like distillation (Millar, 2008).

The study further indicates that the two teachers gave a limited number of activities to aid the learners' understanding of the topic distillation. Consequently, the findings show that both teachers did not conduct hands-on experiment with learners in the classroom as science is supposed to be taught. In this research I have learned that the use of practical work during the teaching of the topic distillation depends on the science teacher and how these practicals are designed. This affected the learners' conceptual understanding of scientific concepts like distillation.

The study revealed that the use of learning and teaching support materials (LTSMs) help the learners to make sense of the topic distillation. It was noticed that the LTSMs like charts, chalkboard and textbooks used by the by the teachers during the teaching of distillation supported teaching and learning science, more especially the topic distillation (Czerniewicz, et al., 2000; Mdlungu, 2006: 32). However, the drawback was that the materials for practical work were not available in the schools.

The findings revealed that elicitation of learners' prior everyday knowledge (PEK) can help the teachers to build on this knowledge for effective teaching and learning of distillation in the classroom (see Section 2.6). Both teachers considered learners' PEK when they taught distillation which helped learners to make sense of the topic (Roschelle, 1995). The study found that the brainstorming session and discussion with the learners about their PEK and experiences about making *Kashipembe*, was in itself educative. The study clearly indicates that the practices of both teachers in using the learners' PEK facilitated learning and contributed to a better understanding of the concepts related to distillation.

Moreover, it emerged from the study that incorporating learners' PEK about making *Kashipembe* as an example; developed the sense making of concepts related to distillation. Rennie (2011) supported that there is a need for teachers to have didactic knowledge in order to assist learners to benefit from their everyday experiences, and I strongly agree with him as the subject content knowledge plays a role in teaching science.

The learners engaged in the lessons presentation actively and also did some written activities both in groups and individually in both schools. Thus, engaging learners in learning through discovery as Mr. Gaps did can arouse the learners' interest in learning science and help to boost the learners' confidence both inside and outside the classroom.

The findings indicate that learners understood the topic distillation through the use of community or indigenous knowledge incorporated during the making of *Kashipembe* by a community member. This was supported by one of the participating teachers (see Appendices H (v) and (vi)). *Kashipembe* can be used in teaching experimental techniques to describe separating of mixtures which involve distillation in chemistry section. Therefore, the practices of making *Kashipembe* can be fruitful in the context where it is being practiced where the learning and teaching materials are not adequate enough, thus agreeing with Czerniewicz, et al. (2000).

The lesson we developed on the topic distillation and the integration of making *Kashipembe* was aimed at enhancing and improving the teaching of the topic distillation in the classroom. It is hoped that the suggestions we made about how science teachers can use teaching strategies when teaching the topic distillation in rural areas would improve the teaching of the topic distillation. And the integration of contextual scientific knowledge in the classroom with community knowledge of making *Kashipembe* served as a sense making of the topic distillation. Overall, the co-development of a lesson and demonstration of making *Kashipembe* facilitated co-learning amongst all of us.

7.3 Recommendations

This section presents the recommendations based on the findings of this study.

The first recommendation is that teachers should start exploring different teaching strategies in order to deliver the required syllabus content to the learners. Teachers should also be more creative about the use of local and readily available materials and develop these materials for effective teaching and learning of science in schools.

Looking at the syllabus of Physical Science Grade 11-12, there is not much emphasis on the use indigenous knowledge and learners' prior knowledge even though the Namibian National Curriculum of Education highlights the use of community knowledge and experiences during teaching of scientific concepts. Therefore, the Namibian curriculum developers need to include this community knowledge in the curriculum to make it easier for the learners to make sense of the topic distillation. With this contextualisation the misconceptions prevailing in the school and community about Physical Science might be addressed. After analysing the syllabus of Grade 11 Physical Science it was clear that the topic distillation was not covered in detail by the curriculum. I therefore, recommend that the topic distillation should be included on its own merit and not partially under experimental techniques on separation of mixtures. This will bring about a better understanding of the topic distillation.

Furthermore, I recommend that community members should be contacted by the educators to use their knowledge on the topics related to scientific concepts. This will help make the connection between the community and school knowledge, which would include learner's PEK and in addition, teachers' strategies might also be improved in the process.

Another recommendation is that demonstration by a community member to the class of a local distillation process as part of learning process can help our learners', noting it is direct linked with the topic.

All in all, I recommend that the teachers should try by all means to get the available local and easily accessible materials and use them to carry out at least one experiment on a practical topic like distillation.

7.4 Areas for future research

Areas for future research for this study will include the following:

First and foremost, a further study should be conducted about the traditional brew called *Kashipembe* referred to in this study so that the percentage of alcohol can be tested and recorded.

Secondly, when making *Kashipembe,* the first extract called *ndenga,* explodes when poured on glowing charcoal. Why this happens would be an interesting area for further study. I also suggest that further studies should be done on distillation but should concentrate on the topic distillation instead of general concepts around distillation in both rural and urban schools of Namibia, South Africa or Southern Africa Development Countries (SADC).

The community member should be invited to come and do the demonstration at school so that all the learners and teachers get a chance to observe and witness the whole process of making *Kashipembe.* This platform would benefit the researcher to obtain more data from the audience who will be part and parcel of the demonstration.

The findings from the analysed data with learners indicated that most learners are in favour of practical activities. This study in itself incorporated prior everyday knowledge of learners and indigenous knowledge in the community of practice. I would like to see a similar study using indigenous knowledge of as the baseline and introduction of the topic distillation in school science.

Further model lessons should be developed and be used by teachers teaching in rural schools where there is a lack of teaching apparatus to carry out distillation in school laboratories.

7.5 Research limitations

In Section 3.10, I described some limitations of this study. However, if I were to do this study again, I would try to include the learners as participants as this would be useful for more data generation. During my research I realised that I needed more data hence my decision to interview the learners on the conversation they engaged in with the community member.

7.6 Conclusion

The findings of the study concluded that the use of different teaching strategies is useful in both teaching and learning of scientific concepts. The study also indicated that use of learners' prior everyday knowledge can help to make sense of the concepts related to distillation. Lastly, this chapter presents my personal reflections and conclusion.

EPILOGUE: MY PERSONAL REFLECTIONS

Reflection is all about the experiences and feelings you have about something for a certain period of time. As we started with our master of education in science at the beginning of the year 2013, our supervisors Dr. Ken Ngcoza and Dr. Charles Chikunda together with Mr. Robert Kraft, the Master of Education coordinator for the Namibian programme, encouraged us to write reflections every day. We did the reflections on our own and also everyday in the morning during contact sessions throughout the course.

The body of this reflection concentrates on my experiences and feelings during the coursework year with some slight changes to the reflection made in the coursework year.

At the beginning of the course I came to notice that, reflection is all about the feelings or experiences during the session rather than the content learned. I had mixed feelings about the master's course, and kept on thinking whether I would make it to the end of my first year 2013. However, through the support of my two supervisors everything became possible.

From the beginning of the year they changed my academic style from where I was after completing my previous qualification. Despite this, I had fears about the whole course but my two supervisors, through their tireless and encouraging support, helped me through.

In addition, I was worried about Mr. Robert Kraft because I had never had a conversation with a white person. I was not sure whether I would be able to catch up with what he would be saying. After sometime, all these fears were cleared as he spoke clearly for everyone to hear and understand the content at hand.

When we started with assignment preparation, I gained control after clarity on aspects which were troubling me from my past studies. The different styles of quoting and referencing were explained by the supervisors. Throughout the course I came to learn that the reason why science students who do a master of education performed and graduated; was because of the supervisors who are supportive throughout the academic process.

Through the guidance and support, Dr. Ngcoza introduced a theory of approach known as: PEEOE (Predict-Explain-Explore-Observe-Explain), which motivated me as this was exactly what academics used to do. In addition, this theory helped me as a practising teacher to instil in my learners some confidence which subsequently contributed to independent learning in various topics in their science subjects. The theory goes hand in hand with the mini-research conducted by learners at different level.

Furthermore, the selection of the research topic also gave me some problems to start with. This is because research was introduced at the beginning of the coursework year, when I was still not sure of where to start and where to end. Nevertheless, all this was attended to by our supervisors and Mr. Kraft's invaluable input. I was advised that once I start writing the first sentence all the work becomes easier as ideas would start coming. They told me that I must not panic when supervisors are advising me to reframe the research focus as this can be changed at anytime without changing the whole research area. My classmates also helped me a lot in this regard until I was on track.

Moreover, I was wondering if I was able to go further with my research as it changed each time after discussion with my supervisors. Later on through their encouragement I managed to start writing down something and felt like I was also studying. Another thing which touched me again was a saying by Dr. Chikunda; when he told us that "if you do not get to PhD you will be regarded as a drop-out". When I thought about it I started feeling that it is true and I just doubled my confidence towards the course and tried to ask questions whenever something was not clear. Thereafter, I started joining the academic journey.

Moreover, the orientation in Grahamstown was a good one and educative in terms of the history of the town and how the town was named. Generally, the orientation of the University and town was excellent, especially the library and Chemistry Department. The library is equipped with all the materials students need for their academic work and its organisation is up-to-standard.

The Chemistry Department inspired me when I entered the laboratory. The outline, laboratory equipment/chemicals and whole set up of the laboratory was just fascinating. When the issuing out of Science Coats started I felt like a science teacher for the first time. All this was because it has been a long time since I put on the Science Coat and carried out an experiment in the laboratory.

The experiment carried out was educative in the sense that it was hands-on activity by each and everyone in pairs. I personally can say that the Chemistry Department at Rhodes University is well organised and equipped with academics that are specialised in the field of chemistry.

The time we spent in Grahamstown went well as it was planned in such a way that supervisors for maths and science mixed up which gave a good impression as they criticised us. I was pleased to present my research interest in South Africa compared to B.Ed Hon which I did some years back. Another thing was the COCKTAIL PARTY, where we enjoyed and celebrated together with our supervisors both from mathematics and science.

Lastly, in Namibia, the assignments continued which was a headache as I was confused on what to start with Proposal or IK assignment or Gender and Science. This was resolved by my supervisors which recommended I should settle the tasks one by one though I still have Research Proposal which I need to finalise and hand it in again before final submission to the Education High Degree Committee (EHDC).

After the first year I was worried about my research proposal as it took several times before it was approved by the EHDC while for my other classmates were already approved. But I just had faith in the slogan from Dr. Ngcoza of **“If you want to walk fast, walk alone; but if you want to walk far walk together”** (African Proverb). Thus, the research proposal was approved in March, which boosted my initial data gathering stage. The whole data gathering process was a headache but Dr. Ngcoza was there for us until we completed all the chapters in the thesis and submitted it in for assessment.

Looking at my experiences I noticed that I learned a lot and have seen many things which I have never seen and experience before. But all these started with one step of education and it opened the door for me to start experiencing the beauty of the academic community.

I love Rhodes University: “where leaders learn”.

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APPENDICES

APPENDIX A

i. Letter to the Director of Education

To the Director of Education

Mr. Shifafure Andreas Muronga
P.O. Box 1877
Rundu
Namibia
24 February 2014

Director of Education)
Kavango (East & West) Regions
Private Bag 2134
Rundu
Namibia

Dear: Sir

RE: REQUESTING FOR A RESEACH SITE IN KAVANGO (EAST & WEST) EDUCATION REGIONS

I, Andreas Muronga Shifafure, Student Number: 613s6272, Cell No: 0813721385 OR 0813237176 is a part time student doing Master of Science Education with Rhodes University, Grahamstown in the Republic of South Africa. I have registered for this course Jan/Feb year 2013 academic year and will complete it this year 2014. One of the requirements for Master Degree is to fully complete and pass a component of research. Therefore, I will do my research this academic year. Proceeding, with that in mind, I am requesting if you will allow me to use your regions to be my research sites.

My research topic:

Understanding the teaching strategies that grade 11 Physical Science teachers use when teaching the topic on distillation in the Kavango (East & West) Regions: A Namibian case study.

I planned to do 4-5 lesson observations, discussions and conduct interviews with the Physical Science teacher and learners I will be working with in science department specifically with a grade 11 science classes at both schools to be chosen in these regions. Furthermore, in the request letters sent to schools I asked for permission to tape record or videotape the interviews, lesson observations and some discussions just for information access after interview or discussions. I am not going to teach, but just observing lessons on distillation.

The school and teachers to be involved are assured of anonymity in the final research report, and the transcription will be given to teacher for proofreading and to make comments where possible. If you are willing to assist me with space for my research, you can just put it in writing and forward it to me as soon as your right office can.

Your support will be highly appreciated.

Yours Sincerely
Shifafure Andreas Muronga

Signature : 24/03/2014
Date

i. Acceptance Letter from the Director of Education

REPUBLIC OF NAMIBIA

KAVANGO REGIONAL COUNCIL

DIRECTORATE OF EDUCATION

Tel. (066) 258 9111
Fax (066) 255 404
Enquiries:

Private Bag 2134
RUNDU
Namibia

Date : 03 April 2014

Mr. A.M. Shifafure
P.O. Box 1877
RUNDU
NAMIBIA

RE: REQUESTING FOR A RESEARCH SITE IN KAVANGO (EAST AND WEST) EDUCATION REGIONS

The above matter has reference.

Permission is hereby granted to Mr. Andreas M. Shifafure, a part time student doing Master of Science to observe lessons and to interview teachers and learners as requested.

Yours faithfully,

Alfons M. Dikuua
DIRECTOR

03/04/2014
Date

KAVANGO REGIONAL COUNCIL
DIRECTORATE OF EDUCATION
2014 -04- 03
DIRECTOR
PRIVATE BAG 2134 RUNDU

All official correspondence must be addressed to the Chief Regional Officer

APPENDIX B

i. Letter to the principal (Yebo Secondary School)

Letter to the principal

Mr. Shifafure Andreas Muronga
P.O. Box 1877
Rundu
Namibia
07 November 2013

Mr. ....
Yebo Senior Secondary School
P. O. Box 1751
Rundu
Namibia

Dear Sir

RE: REQUESTING FOR A RESEACH SITE

I, Andreas Muronga Shifafure, Student Number: 613s6272, Cell No: 0813721385 is a part time student doing Master of Science Education with Rhodes University, Grahamstown in the Republic of South Africa. I have registered for this course Jan/Feb year 2013 academic year and end next year 2014. One of the requirements for Master Degree is to fully complete and pass a component of research. Therefore, I will do my research next year 2014, with that in mind, I am requesting if you will allow me to use your school as one of my research sites for the research report which I am required to write next year.

My research topic:
An investigation into how Physical Science teachers mediate learning when teaching distillation topic in grade 11 Kavango Region: A case study.

I planned to do 2-3 lesson observations, discussions and conduct interviews with the teachers I will be working with in science department specifically with grade 11. Furthermore I am asking for permission to tape record the interview, lessons and some discussions just for information access after interview or discussions. I am not going to teach, but just observing lessons on distillation.

The school and teachers to be involved are assured of anonymity in the final research report, and the transcription will be given to teacher for proofreading and to make comments where possible. If you are willing to assist me with space for my research, you can just put it in writing and forward it to me as soon as you can.

Your support will be highly appreciated.

Yours Sincerely

Shifafure Andreas Muronga

ii. Acceptance letter from the principal (Yebo Secondary School)

[redacted]
P.O. BOX 1751
RUNDU
NAMIBIA

Enquiries: Mr P.V. Musore **Tel**: 066 – 686 081/2 **Email**: amribebess@gmail.com

28 February 2014

<u>To whom it may concern: Mr. Andreas Muronga Shifafure</u>

Subject: Letter of Attendance

This is to testify that Mr.Shifafure was at our school for two weeks (10-14 February and from 24-28 February 2014 respectively) doing his research for a Master Degree, which he is studying with Rhodes University.

During his stay, Mr. Shifafure was very co-operative and also helpful to the staff and learners of the school.

I wish Mr. Shifafure success in his course.

[redacted]
School Principal

MINISTRY OF EDUCATION
THE PRINCIPAL
ANGELINA MATUMBO RIBEBE S. SCHOOL
2014 -02- 2 8
PRIVATE BAG 2134
RUNDU
REPUBLIC OF NAMIBIA

28/02/2014
Date

APPENDIX C

i. Letter to the principal (Tushetekenu Secondary School)

Letter to the principal

Mr. Shifafure Andreas Muronga
P.O. Box 1877
Rundu
Namibia
07 November 2013

Mr. ....
Tushetekenu Senior Secondary School
Private Bag 2078
Rundu
Namibia

Dear Sir

RE: REQUESTING FOR A RESEACH SITE

I, Andreas Muronga Shifafure, Student Number: 613s6272, Cell No: 0813721385 is a part time student doing Master of Science Education with Rhodes University, Grahamstown in the Republic of South Africa. I have registered for this course Jan/Feb year 2013 academic year and end next year 2014. One of the requirements for Master Degree is to fully complete and pass a component of research. Therefore, I will do my research next year 2014, with that in mind, I am requesting if you will allow me to use your school as one of my research sites for the research report which I am required to write next year.

My research topic:
An investigation into how Physical Science teachers mediate learning when teaching distillation topic in grade 11 Kavango Region: A case study.

I planned to do 2-3 lesson observations, discussions and conduct interviews with the teachers I will be working with in science department specifically with grade 11. Furthermore I am asking for permission to tape record the interview, lessons and some discussions just for information access after interview or discussions. I am not going to teach, but just observing lessons on distillation.

The school and teachers to be involved are assured of anonymity in the final research report, and the transcription will be given to teacher for proofreading and to make comments where possible. If you are willing to assist me with space for my research, you can just put it in writing and forward it to me as soon as you can.

Your support will be highly appreciated.

Yours Sincerely
Shifafure Andreas Muronga

ii. Acceptance letter from the principal (Tushetekenu Secondary School)

DR.R. KAMPUNGU

[redacted]

P.O. Box 33
Tel: 066255086
Fax: 066255176

Enquiri [redacted]
Email: [redacted]

19 May 2014

TO WHOM IT MAY CONCERN

This letter serves to inform you that Shifafure Andreas Muronga did conduct his research studies at this institution starting from 13 May 2014 to 19 May 2014.

He is a well behaved person and the teachers enjoyed his research.

We wish him the best in his studies.

Yours in Education

[redacted]
HOD

MINISTRY OF EDUCATION
THE PRINCIPAL
DR. R. KAMPUNGU SEC. SCHOOL
19 MAY 2014
REPUBLIC OF NAMIBIA

iii. Letter to the community member on making Kashipembe

Letter to the community member

Mr. Shifafure Andreas Muronga
P.O. Box 1877
Rundu
Namibia
07 November 2013

Community member
Ncaute Village
Private Bag 0000
Rundu
Namibia

Dear Madam (Kuvanane)

RE: REQUESTING FOR A COMMUNITY MEMBER TO DEMOSTRATE MAKING OF KASHIPEMBE.
(LISHUNGIDO LYAKUKA NEGHEDA OMO VAKENDJANGA KASHIPEMBE)

I, Shifafure Andreas Muronga, is currently a science and mathematics teacher at the who is doing part-time Degree of Master of Science Education with Rhodes University, South Africa. I am hereby requesting from you to be a community member or a participant my research which I will be conducting next year 2014.
Ame, Shifafure Andreas Muronga, mitiri wamuvaru navivyakumawoko, ame kuna kukushongera Master of Education mu Rhodes University, South Africa. Mbyo ngoli nakumushungida ngomuya kare umwe wamumukunda ngayahameno mumakushongo ghano nganiruwana 2014.

Therefore, what I want you to do is to, show, explain, demonstrate and answer any question to be posed regarding Kashipembe. Kashipembe was opted for because the topic distillation is linked to this cultural practice which might make learner to understand distillation better in the classrooms.
Mpo ngolisi anwe viruwana vyenu ngaviyakara, vyakuneyeda, kutantera nakulimburura mapuro keheghano ghokuhamena Kashipembe. Ame kwa ghupira Kashipembe mbyovyoshi mporuli ruha roshirongwa varuwananga vanuke kwafana tupu momu varuwananga Kashipembe. Mposi evi kuvatera vanuke vayuvheko kuruha rwashirongwa shino shevi vyakumawoko.

In the same vein your personal information will not be told to any one as I will just use it for study puporses.
Monka shimpe ashi maukenu ghokuhamena kukwenu ghokuruwanita tupu mumakushongo kapi nganigha tanta kuvantu navo peke.
Finally, I would like you to tick in the box below if you accepted my request and cross in the box if you rejected my request ☐ .
Mukuhulilira, nahoro mukoreke mushimbangu shino ntjeneshi munavitamburako ntani midishure momushimbangu ntjene kapimunavitamburako ☐ .

Your cooperation is highly appreciated. [Mpandu kuliruwaneno kumwe]
Yours in education [Wenumumakushongo]
Teacher: Mr. A. M. Shifafure

iv. Letter to the parents of learners in two grade 11 classes

Letter to the parents

Mr. Shifafure Andreas Muronga
P.O. Box 1877
Rundu
Namibia
07 November 2013

Parents of learners
Tushetekenu and Yebo school
Private Bag 9999
Rundu
Namibia

Dear Sir/Madam (Vava ndi Vanane)

RE: REQUESTING FOR YOUR CHILDREN TO BE PARTICIPANTS DURING CLASSES AND MAKING OF KASHIPEMBE.
(LISHUNGIDO LYAVANAVENU NGAVA HAMENE MUMAKUSHONGO GHANDE MUNKONDWARONGERO NOMUKAKENGERA OMO VAKENDJANGA KASHIPEMBE)

I, Shifafure Andreas Muronga, is currently a science and mathematics teacher at the who is doing part-time Degree of Master of Science Education with Rhodes University, South Africa. I am hereby requesting from you to permit your children to participants in my research which I will be conducting next year 2014.
Ame, Shifafure Andreas Muronga, mitiri wamuvaru navivyakumawoko, ame kuna kukushongera Master of Education mu Rhodes University, South Africa. Mbyo ngoli nakumushungida ngomu mpulitire kuruwana kumwe novavna venu ngava hamene mu mumakushongo ghano nganiruwana 2014.

In the same vein, your children's' your personal information will not be told to any one as I will just use it for study purposes.
Monka shimpe ashi maukenu ghokuhamena kuvana venu ghokuruwanita tupu mumakushongo kapi nganigha tanta kuvantu navo peke.

Finally, I would like you to tick in the box below if you accepted my request and cross in the box if you rejected my request ☐ .
Mukuhulilira, nahoro mukoreke mushimbangu shino ntjeneshi munavitamburako ntani midishure momushimbangu ntjene kapimunavitamburako ☐ .

Your cooperation is highly appreciated. [Mpandu kuliruwaneno kumwe]
Yours in education [Wenu mumakushongo]
Teacher: Mr. A. M. Shifafure

APPENDIX D

i. Pre-Interview questions

Pre-Interview questions to the Physical Science teachers

1. What are your views on learners' understanding of concepts of the topic on distillation?
2. How do you introduce your lessons when teaching the concepts on distillation?
3. What are your views on learners' everyday knowledge when teaching the topic on distillation?
4. What teaching strategies do you use when teaching the topic on distillation?
5. (a) What factors enable learners to make meaning of the concepts on topic distillation?
   (b) What factors constrain learners not to make meaning of the concepts on distillation?
6. (a) What are some of the problems you face when teaching the topic distillation?
   (b) How do you solve the problems which you face when teaching the topic distillation?

ii. Post-Interview questions

1. Do you think that you considered learners everyday knowledge when you presented the lessons on distillation?
2. Do you think it was important to study the topic of distillation in the classroom like we just did it with the learners?
3. Maybe looking at the lesson you have just presented, may you tell me what type of teaching strategies you have used?
4. Do you think that lack of materials have effect on the teaching of the topic distillation?
5. Looking at your lessons in general, what do you think went well and what do you think did not go on well?
6. Now, in general what are your suggestion or recommendations with regard to lesson presentations and the whole face of the study?

iii. Guiding questions during brainstorming session with Grade 11 classes

1: What types of fruits are being used in the community to make Kashipembe?

2: Explain how Kashipembe is made? Give the step by step procedures. Here you are required to list the step by step procedures on how Kashipembe is made.

3: What apparatus/materials are used to make *Kashipembe*?

4: Who normally makes *Kashipembe* man or woman?

5: How many days can it take to make *Kashipembe*? And give a reason to support your answer.

6: Who is allowed to drink this *Kashipembe*?

7: What some of the scientific concepts or terms associated with *Kashipembe?*

8: Do you think the making of *Kashipembe* is a good practice or not in the community? And support your answer.

iv. Interview questions with a community members.

IQ- Interview question
RT-Researcher's translation

1. *IQ: Nyango munke mwaruwanitanga murenke Kashipembe?*
   RT: What types of fruits do you use to make Kashipembe?
2. *IQ: Lipuro lyokukwama, walye tutante tupu maghuyivi ghenu weni mwaruwananga Kashipembe? Yira weni omo avarekanga kadidi-kadidi tupu vene mukuwapayikira dogoro kukakendja.*
   RT: Next question, may you please tell me your experiences or what you know on how do you make *Kashipembe* step-by-step from the beginning of preparation until to the distillation process?
3. *IQ: Ya kughupako vinya. Lipuro lyoghutatu. Vighamba munke mwayuvha ko vyokuhamena Kashipembe? Turenke tupusi shihoninito yira kumukuro. Asi nkene ghuna karapanyama kwato kuyenda kumukuro nevisi ngakakukwata mvhuu. Kukasipembe ngoli kwato vyo mwayivako vyokufana ngoli.*
   RT: Ok. Apart from that. The third question. What kind of story is there in connection of *Kashipembe*? Taking an example of the river. They said if you had sexual intercourse you should not go to the river as you might be attacked by Hippopotamus. Do you know anything like that with *Kashipembe*?
4. *IQ : Walye viruwanita munke mwa hepa mposi muruwane Kashipembe?*

RT : What materials do you need in order for you to make Kashipembe?

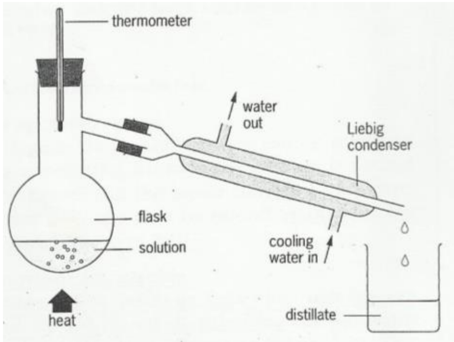
5. *IQ : Walye oghu Kashipembe varenani ava vafero kumuruwana vakamali ndi varume? Tutureko nonokonda tupu.*
   RT : Who supposed to make Kashipembe, males or females? Give reasons.
6. *IQ : Walye mayuvamangapi aghupanga Kashipembe ntani vakamukenga. Kuvarekera tupu pakumanakumurunga vitwaretupu kumeho dogoro kukakendja?*
   RT : How many days do Kashipembe take before it is ready to be made? Just starting from the mixing of contents until the day of distillation process.
7. *IQ : Nkene muna mana kukendja Kashipembe, vare vafero ngoli kumunwa?*
   RT: If you are done making Kashipembe who supposed to drink it?
8. *IQ: Omo mwavimonangako ngoli nwe, vidonandi viwa kukendja Kashipembe umughulite mumukunda?*
   RT: How do you look at ther making of Kashipembe, is it good to make and sell it in the community?
9. *IQ: Vinke vatuliranga ko suka kuvirungarunga vyaKashipembe?*
   RT: Why do people add sugar to the mixtures or contents of making Kashipembe?

v. Semi-structured interview with the learners to make meaning about their community visit and follow-up Kashipembe.

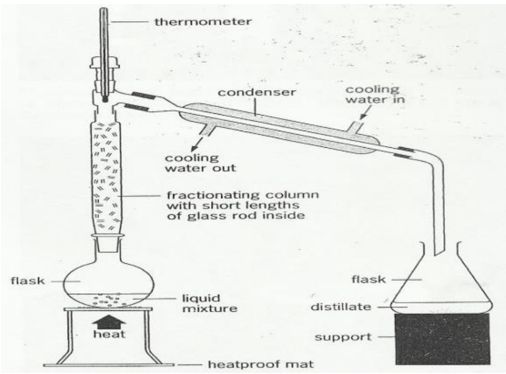
IQ.1: Do you think science teachers should consider learners prior everyday knowledge when they are teaching distillation?
IQ.2: Do you think it is importance to involve a community member in the learning of science (distillation) at school? Like the way we are doing it now with the woman who is preparing Kashipembe.
IQ.3: Looking at the topic presented, do you think it helped all the learners or just the few of the learners?
IQ.4: How do you look at practical work in Physical Science on the topic distillation?
IQ.5: How do you feel to be a participant of this study?

APPENDIX E GCSE Chemistry; Earl and Wilford (1995: 20-21). Figures of simple and fractional distillation

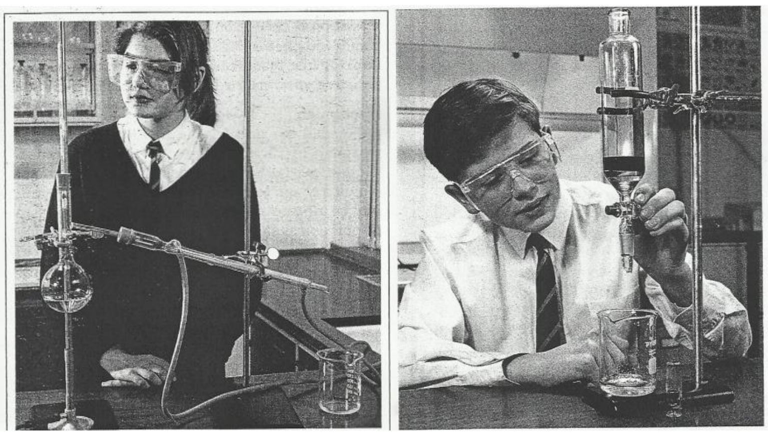
i. **Labelled diagram of Simple Distillation apparatus**



ii. **Labelled diagram of Fractional Distillation apparatus**

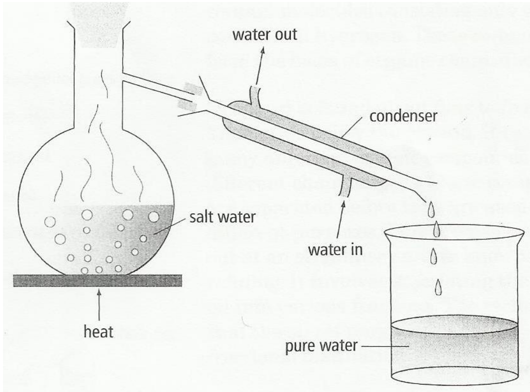


iii. **Photographs from the textbook of male and female learners carrying out experiment**

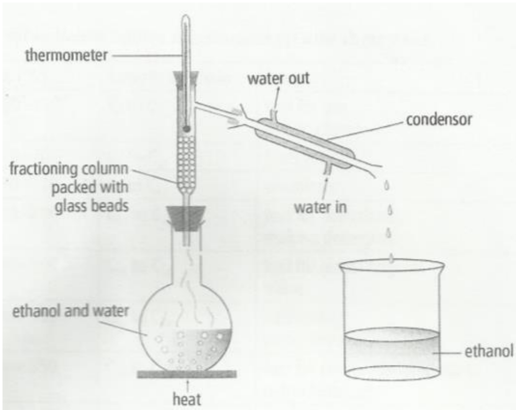


APPENDIX F. NAMCOL Module 3; Kachinda and Ajayi (2009: 11-12).

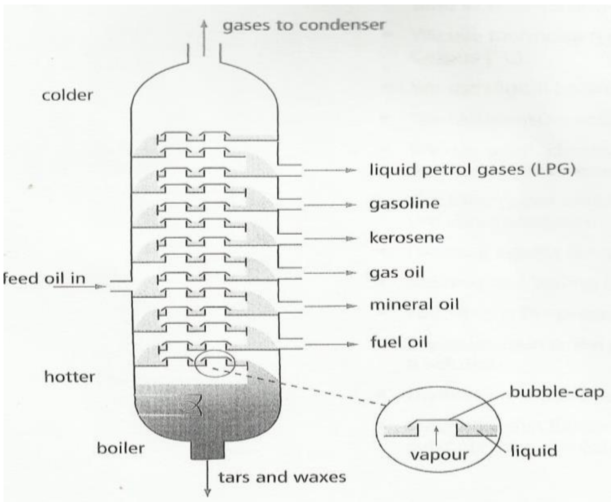
i. **Simple distillation**



ii. **Fractional distillation**



iii. **Fractional column used to separate petroleum**



iv. Summary

- We use dial and digital stopclocks and stopwatches to measure time in seconds and minutes.
- We use thermometers to measure temperature in degrees Celsius (°C).
- We use digital balances and lever-arm balances to measure mass.
- We can measure volume with a measuring cylinder, burette or pipette.
- We use paper chromatography to separate mixtures of dyes and to find out what substances are in a solution.
- The filter paper which shows the coloured rings (results) is called the chromatogram.
- Locating agents are used to develop colour in non-coloured substances.
- Melting and boiling points are unique for each substance.
- Filtration is the process we use to separate solids from a liquid.
- Crystallisation is the process we use to separate a solid from a solution.
- Distillation is a process we use to purify a solvent from a solution.
- Fractional distillation is the process we use to separate several solvents from a solution.

APPENDIX G

i. Unit of work

UNIT OF WORK

CHEMISTRY SECTION SYLLABUS

TOPIC: Experimental Techniques

General Objectives:
Learners willunderstand the principles of experimental techniques

Specific Objectives:
Learners should be able to describe methods of purification by the use of a suitable solvent, Distillation (simple and fractional) (including use of fractionating column).

DEFINITION OF TERMS

- **Mixture is** the composition of different substance liquid and liquid, solid and solid or liquid and solid.
- **Soluble** the ability of a substance (*liquid)* to dissolves into another substance (*liquid).*
- **Insoluble the** inability of substance to dissolve into another substance.
- **Distillation** is the process of boiling a liquid and then condensing the vapour produced back into a liquid. It is used to purify liquids and to separate mixtures of liquids
- **Simple distillation** the simple separation of a solid and a liquid by evaporating the liquid and collecting it after it passes through a condenser to be changed into a liquid state.
- **Fractional distillation**a process that separates more than one substance at a time, is used when boiling points are different or when mixtures are complex. (eg. ethanol and water). These can be separated since they both have different boiling points.
- **Condensation** is when vapour changes to liquid
- **Evaporation** is when liquid changes to gas
- **Distillate** is the purified liquid which is collected in receiver during distillation. Eg. ethanol
- **Miscible** when substances can mix with each other. E.g. ethanol and water
- **Immiscible** refer to substance that do not mix easily e.g. oil and water
- **Solution** is a mixture of a solute and solvent. E.g. sugar into water
- **Boiling point** is the highest temperature at which substance can change its state from a liquid to a gas. E.g. water boils at 100 ^{0}C and alcohol 78 ^{0}C.
- **Solvent** substance into which another substance dissolves. E.g. water

DESCRIPTION OF DISTILLATION PROCESSES

How to separate the solvent from a solution (e.g. Salt and water) by simple distillation

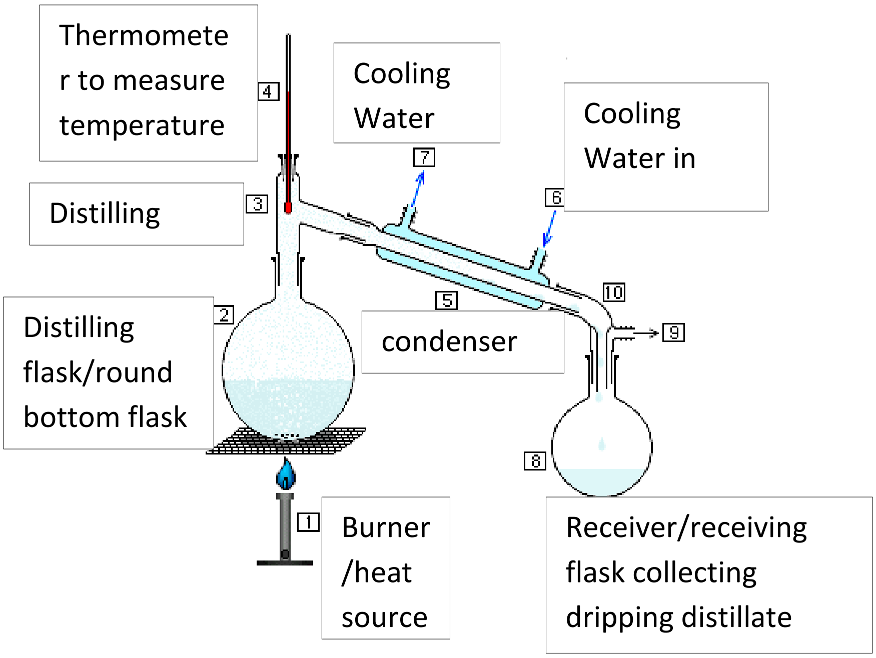
<u>The following happens during the process:</u>

- The solution is heated in the flask. It boils, and steam rises into the condenser. The salt is left behind in the flask.
- The condenser is cold, so the steam condenses to water in it.
- The water drips into the beaker. It is now pure. It is called distilled water

This method could also be used to obtain pure water from seawater, or from ink.

Simple distillation makes thousands of products possible, from white **vinegar** to extra-extra **virgin olive oil**, **beer** to **vodka**, solvents, household cleaners, face creams, hair dyes and more. Simple distillation helps make production simple and economical, creating more products for consumers.

Description of Simple distillation with references to apparatus used



How to separate two liquids (e.g. Ethanol and water) by fractional distillation

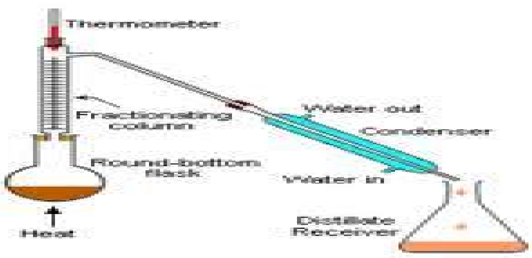
If two liquids are **miscible** they must be separated by fractional distillation

<u>The following happens during the process:</u>

- ✓ The mixture is heated. At about 78 ^{0}C, the ethanol begins to boil. Some water evaporates too, so a mixture of ethanol vapour and water vapour rises up the column.
- ✓ The vapours condense on the glass beads on the column, making them hot.
- ✓ When the beads reach about 78 ^{0}C, ethanol vapour no longer condenses on them. Only the water vapour condenses. The water drips back into the flask, while the ethanol vapour is forced into the condenser.
- ✓ There it condenses. Liquid ethanol drips into the beaker.
- ✓ Eventually the thermometer reading rises above 78 ^{0}C. This is a sign that all the ethanol has been separated, so heating can be stopped.

This method could also be used to separate individual gases from air, and crude oil.

Description of Fractional Distillation with references to the apparatus used



ii. Test questions Tushetekenu Secondary School

TEST: TOPIC DISTILLATION

1. Explain the following :

   a. Distillation

   ____ [1]

   b. Condensation

   ____ [1]

   c. Distillate

   ____ [1]

2. What is the difference between simple distillation and fractional distillation? [3]

   ____

3. Two important processes that involve distillation are the manufacture of brandy and whisky. Brandy is made by distilling wine; whisky is made by distilling beer. Both brandy and whisky contain alcohol (boiling point, 78 ^{0}C) and water (boiling point, 100 ^{0}C).

   (a) Which liquid boils at lower temperature, alcohol or water? [1]

   ____

   (b) Which of these two liquids (alcohol and water) evaporates more quickly, give a reason to support your choice? [2]

   ____

   (c) If beer is distilled, will the distillate contain a larger or smaller percentage of alcohol, give a reason for your answer? [2]

   ____

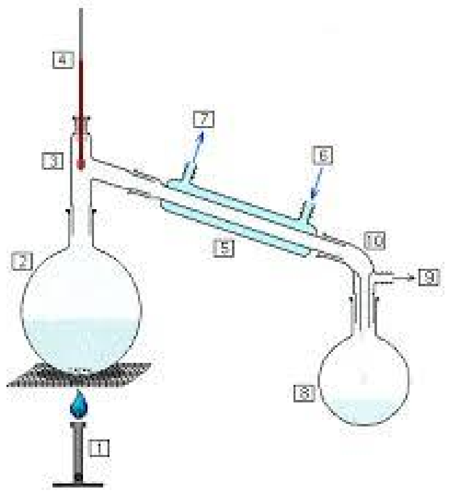
   (d) Why is whisky more alcoholic than beer? [1]

   ____

   (e) Apart from brandy and whisky give at least two examples of substance prepared through distillation processes. [1]

   ____

4. The diagram shows set-up apparatus used in one of the distillation processes. Study it and answer the questions that follow.



i. What type of studied distillation processes does the apparatus above represents? [1]

____

____

ii. Label the parts with numbers below and state their functions

Number **1**____

Function: ____ [2]

Number **4** ____

Function:____ [2]

Number **8** ____

Function: ____ [2]

TOTAL MARKS: 20

PASS: 100% - 50% (A-D)
FAIL: 49% - 0% (E-U)

GOOD LUCK\\

iii. Test Yebo Secondary School

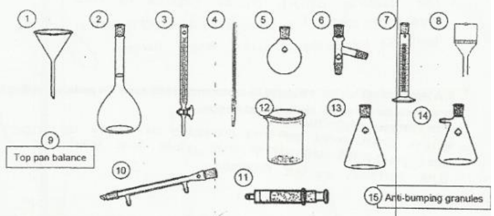
Kalungungu Jenitha
11 A

Physical science
Term 2
Tes 1: Experimental Techniques

17/38

Total marks: 38
date: 19/05/2014

You have just started in a new research lab and have the following equipment available to you. **Choose** which piece(s) of equipment you would use for each of the following tasks and **name** each piece you use. You can assume you have plenty of bungs, tubing and adaptors plus access to a safe source of heat;



1. To measure the volume of carbon dioxide produced by the following reaction;

   ethanoic acid + sodium hydrogen carbonate → sodium ethanoate + water + carbon dioxide

   aparatus 4,
2. To obtain pure water from a sample of salt water

   - Evaporation, apparatus 14
3. To oxidise a sample of propan-1-ol to propanoic acid by heating with an excess of an acidified aqueous solution of sodium dichromate under reflux conditions

   apparatus 6,
4. To make up an accurate 0.05 mol dm^{-3} solution of sodium hydroxide

   - apparatus 9, Top ban balance
5. To recrystallise a sample of paracetamol contaminated with an insoluble solid impurity and collect the solid product

   = Filtration, apparatus 12.

(2 marks for each correct set of equipment correctly named)

6. How do impurities affect the melting point of a solid? (2)

= ~~the melting point of a solid is very low since impurities does not support low melting.~~
- particles in solid they are close to each other, so the melting point will be affected.

7. How do impurities affe . the boiling point of a liquid?(2)

= The boling point of a liquid is not really affected liquid will boil quickly when boiling because it will melt easly.

8. A sample of salt has be found to be contaminated with some dirt particles. Outline the method to separate the salt crysta from the dirt particles.(5)

= ~~Filtration~~ distillation
- When salt and ~~the~~ dirt particles are heat up the dirt particles will drop out, while the soil will remain in the receiver.

9. Why are simple distillati n and fractional distillation not appropriate methods to separate immiscible liquids with dif rent boiling points?(3)

- because immiscrible liquids donot allow any substance/liquid to. mix with them, with different boilling points.

10. How should a chromat gram be treated if the substances are colourless such as amino acids?(2)

- It should be treated differently from other, so that the amino acid is not colloureless next time, need to be kept nity, dry.

11. Define the following te ms and give an example where necessary evaporation, residue, distillate, immiscible. (6)

Evaporation = is the state change that take place from liquid to gas - e.g liquid to gas

residue = are substance that remain during a filtration process e.g. chalk.

distillate - purified liquid that is collected in a receiver at the end of the distillation process - e.g sand

Immiscrible = Inability of substance to mix e.g water and alcohol.

12. Name the apparatus used in fractional distillation and state the difference in apparatus used in simple distillation.(8)

- Condeser
- Filtrate
- residue
- thermometer
- Filter paper

iv. Class list with marks Tushetekenu Secondary School

Physical Science Grade 11 Distillation Test

Learners	Date of birth	20	100
1	31/01/92	15	75
2	14/11/95	12	60
3	15/03/93	14	70
4	12/09/91	14	70
5	23/12/92	16	80
6	23/01/90	8	40
7	05/05/97	15	75
8	21/03/93	12	60
9	16/08/93	15	75
10	25/11/95	17	85
11	29/12/94	12	60
12	16/07/91	15	75
13	10/12/90	11	55
14	03/10/91	15	75
15	09/08/90	17	85
16	29/08/93	13	65
17	11/09/94	14	70
18	18/10/92	14	70
19	28/12/93	15	75
20	28/10/95	15	75
21	22/08/95	11	55
22	24/07/90	14	70
23	23/04/93	15	75
24	12/13/1993	13	65
25	15/12/93	14	70
26	24/12/94	15	75
27	03/07/91	15	75
28	11/09/95	15	75
29	16/04/93	15	75
30	31/06/1989	12	60
31	20/01/90	12	60
32	30/06/87	14	70
33	13/08/92	15	75
34	27/03/94	15	75
35	12/09/91	13	65
36	09/08/91	15	75
37	31/12/92	15	75
38	16/11/95	15	75
39	01/07/95	14	70
40	28/07/94	14	70
41	29/08/93	15	75

42	02/09/94	13	65
43	31/05/94	15	75
44	14/11/95	14	70
45	04/03/94	15	75
46	04/12/89	15	75
47	06/11/91	15	75
48	06/08/95	13	65
49	09/06/94	14	70
50	18/10/94	13	65

v. Class list with marks Yebo Secondary School

GRADE 11

RESULTS of Test on Distillation

Marks

Learners	38	100
1.	17	45
2.	25	66
3.	32	84
4.	31	82
5.	37	97
6.	29	76
7.	32	84
8.	30	79
9.	29	76
10.	32	84
11.	35	92
12.	29	76
13.	34	89
14.	28	74
15.	27	71
16.	30	79
17.	18	47
18.	29	76
19.	31	82

vi. One lesson plan Tushetekenu Secondary School

LESSON PREPARATION FORM

NAME: Mr Kahare
DATE: 15/05/2014
SUBJECT: Physical Science
GRADE: 11
THEME: Chemistry Section
DURATION: 40 minutes
TOPIC: Experimental technique
PERIOD(S):

OBJECTIVE(S)

Learners will understand the principles of experimental techniques

BASIC COMPETENCIES:

Learners should be able to describe methods of purification by the use of suitable solvent : Salt and water for simple distillation

TEACHING MATERIALS:

Chalkboard, unit of work, textbook, syllabus

PRESENTATION:

TIME	CONTENTS	TEACHER'S ACTIVITY	LEARNERS' ACTIVITY
5min	INTRODUCTION:		
	Recapitulating on the previous presented lesson	Ask learners to define terms to see if they can still remember what was learned	Should be able to define terms learned previously.
25min	PRESENTATION:		
	Description of simple distillation process		

SECONDARY SCHOOL LESSON PREPARATION FORM Page 1

TIME	CONTENTS	TEACHER'S ACTIVITY	LEARNERS' ACTIVITY
	Describing how to separate solvent from solution.	Ask learners to describe how to separate solvent from a solution.	Should be able to describe the separation of solvent from solution.
	Explaining on what use to happen during the process of simple distillation.	Ask learners to explain the process correctly write down step by step procedures.	Should be able to explain the step-by-step procedure
10min	CONCLUSION:		
	Summarising the lesson	Ask learners to sum up the lesson through questioning them.	Should be able to sum up the lesson as required by the teacher.

HOME WORK/ ASSESSMENT:
Ask learners to study steps and be able to explain it to the class the next day.

REFLECTIONS:
Good lesson as learners present participated in the lesson fully

SIGNATURE OF TEACHER: [signature] DATE:
SIGNATURE OF HOD/PRINCIPAL: DATE:
SIGNATURE OF AT/IE: DATE:

SECONDARY SCHOOL LESSON PREPARATION FORM Page 2

vii. One lesson plan Yebo Secondary School

2

SCIENCE AND MATHEMATICS LESSON PREPARATION FORM

SUBJECT: Physical science

DATE: 02/07/2014

TEACHERS NAME: Mr Muira

TIME: 40 MINUTES

GRADE: 11

PERIOD: 1 2 3 4 5 6 7 8 9

THEME:
Chemistry section

TOPIC:
Experimental techniques

LO: LEARNERS WILL:
Understand the principles of experiment techniques.

BC: LEARNERS SHOULD BE ABLE TO:
Describe the methods of purification by the use of suitable solvent, filtration, crystallisation re-crystallisation, and distillation (including fractionating column).

LSM: *CHALKBOARD, SYLLABUS, TEXTBOOKS* Poster.

PRESENTATION OF THE LESSON

1. MONITORING OF HOMEWORK DONE:
Ask learners to explain what they have read.

2. AN APPROPRIATE SHORT INTRODUCTION:
Recapitulate on defining terms of previous lesson.

3. PRESENTATION OF SUBJECT MATTER AND LEARNING ACTIVITIES:
Description of distillation process

How to separate the solvent from solution by simple distillation.

The following happens during the process:

- The solution is heated in the flask. It boils and steam rises into the condenser. The salt is left behind in the flask.
- The condenser is cold, so the steam condenser water in it.
- The water drips into the beaker. The water now is pure. It is called distilled water.

The method is also used to obtain pure water from seawater or from ink.

· The set up apparatus of Distillation on a diagram/poster/chalkboard will be used.

4. CONSOLIDATION:
Summarise main lesson.

5. ASSESSMENT/HOMEWORK/CLASSWORK/EXCERCISE:
Learners will be ask individual to mention the apparatus used during ~~disti~~ simple distillation process.

6. ENGLISH ACROSS THE CURRICULUM.
READING AND WRITING ACTIVITIES:
Condenser, burner, receiver pronounce and spell correctly.
COMPESATORY TEACHING:

REFLECTIONS:

SIGNT: SUBJECT TEACHER: [signature] DATE: __/__/'14 PRINCIPAL/HOD: ______ DATE: __/__/'14

APPENDIX H: All theTranscripts

i. Pre-interview Mr. Strong at Tushetekenu Secondary School
IQ.1. =Interview question one TR=teacher's response FQ=follow-up question

IQ.1. How do you introduce your lesson when teaching the topic on distillation?

TR: "I intoduce them according to basic competencies".

FQ; How do you now put the lesson on these basic competencies?

TR: "Actually when it comes to basic competencies, I actually explain to them what are, if we are starting a new topic I actually explain to them what is required of them to know from that topic before we will kick on with the lesson".

IQ.2. How do you consider or make sure that learners use the views of their prior knowledge on the topic of distillation?

TR: "Ah, how we teach here we teach according to the way which we call learner centred. The learners do more work than the teachers just to keep them busy. So, what we do is before we start with the lesson, you actually find out what they know about certain things of that topic and so on and than from there you build on what they already put as a foundation".

IQ.3. What are your views of learners understanding of the concept distillation?

TR: "My views on learners understanding is that, ah the way the syllabi are structured is fine so far. But now when it comes to a teacher you yourself should to study how the learners understand. If they understand like let us say the outline the steps of distillation first and then you and show them the apparatus or you use the apparatus to show them to outline the steps. But I myself I have found out that it is easier to have them know the apparatus and from the apparatus then you build on the steps. Because the apparatus will be mentioned in the steps because if they do not have the ideas of the apparatus then when it comes to steps they get confused. So it's best they know the apparatus first before you outline the steps".

IQ.4. What are the teaching strategies you use when you are teaching the topic distillation?

TR: "Distillation! Ah, our teaching strategy as I said is learner –centred and one of them is sending them out to find out more about distillation".

FQ: You just mentioned that you use to send them out to find out about distillation. How do they do it?

TR: "They have to go and discover out for themselves like the end product of distillation and how this process is carried out in the industries not as outlined in the books".

IQ.5. What are the factors which help learners to understand or make meanings of this topic distillation? (What factors enable learners to understand the topic distillation? **Reframed).**

TR: "The factors are just the terms. If they don't understand the terms it's going to be difficult for them to understand the topic".

FQ: "Apart from that, are there some other factors which make learners not to understand the topic of distillation better?

TR: "So far I did not come across a situation which affects learners not to understand the topic of distillation".

IQ.6. Looking at this topic it is like one of the practical topic were learners might be required to do experiments. Just in planning, by looking at it, do you think you have all the material that you can use to carry out these experiments?

TR: "Ah, some material we do have, but most of the time what we do is we use visual aids. We get videos from internet that exhibit distillation then we play them. Because these can be replayed over and over again. And we can give these videos to the kids when they go home they can still look at it. Other than just doing the experiment there and then they just do it once and that's all. So we combine the experiments once and then the videos also then the videos they can take home".

IQ.7. Apart from that, are there any problems generally in Physical Science when you are teaching the topic like distillation?

TR: "The general problem is just the definitions, where they are used to English definitions and not science definitions that becomes a problem also".

FQ: "You said the problem is definitions, maybe how do you try to solve these problems of definitions?

TR: "So, we are encouraging them to get for themselves the science dictionaries, so when they are in the science class we refer them to the science dictionaries instead of the English dictionaries".

ii. Pre-interview Mr. Gaps at Yebo Secondary School
IQ=Interview question TR=teacher's response FQ=follow-up question

IQ.1.: How do you introduce your lesson when you are teaching the topic of distillation?
TR: Eh, normally when I am teaching that topic. So, firstly I use to ask learner about what they know about that topic. Since this is a science topic it is always good to give the learners the definition first, of the concepts that are involved on the topic of distillation. So, they have to know whatever definition of the terms that have been used first then from there you proceed.
FQ: You said you have to start with definition first, how do you do it, you have to define them yourself or how do you do it?
TR: First you give them the chance to go and find out about the definitions themselves so that they can come to the class and discuss about it before you can give them the right definitions.

IQ.2.: How do you consider or make sure that learners use their prior knowledge when you are teaching the topic distillation?
TR: Eh, this one is used to be done by giving them chance to come up with their own idea on what is happening at home. Then, from there you will see if they have that knowledge and then you see if it is linked to science or not.
FQ: How do you see the use of prior knowledge when it comes to learners who are rural area, how do you find it to teach them this topic?
TR: I think prior knowledge to learners is very much important role on learning because it gives a teacher a way on how can you build on for the understanding of the learners. Because these learners will always start from the beginning, you must know where this

learner is ending so that you should be able to build on what the person knows already. That will also help a learner to be involved more in the physical science research.

IQ.3.: What are your views of learners understanding of the concept distillation?
TR: Eh, learners they are there a bit but not really since they are still relying in the traditional way. They do not have ideas that these things that we are doing at home they are also part and parcel they are linked to science that we are doing at school. But if you look at the topic more, I think they will be able to link to what is happening in daily life.

IQ.4.: What are the teaching strategies you are using when you are teaching the topic distillation?
TR: Eh, basically, when I am teaching this topic I use learner centred education as they said first the learners should be involved in doing the things. Therefore, much of the work should be done by learners. And then, my task is just to guide while they are doing the work. To make sure learners are doing the right things. And learners should do more and the teacher is just facilitating learning. But most of the tasks should be done by the learners.
FQ: Apart from learner centred education, are there other methods or strategies of teaching you use?
TR: Yah, there some but learner centred is just the best. Because these things of a teacher to be the expert that time the learning was not good at all. Because sometime you think that what learners are taking is correct but in real sense learners are not enjoying it. When they do things they enjoy it and when they are doing things they are keeping on remembering the things that will help them. Instead of just a teacher going there and preach at the end the learner get bored and will not enjoy and ends with no learning takes place.
IQ.5.: What are the factors which help learners to understand or make meaning of the topics on distillation?
TR: Right, this one as you know science has to be done by doing things not just theoretical. So the most important things here is learners to do the things practically, have to be hands-on, whatever things they do have to see it. So, whatever comes have to know the outcomes of what they are doing and then from there they will be able to grasp the content.
FQ: Good. You just mention about practical, if you look at this topic of distillation it's also one of the practical topics. Do you think you have all the material to be used when you are carrying out the experiment on this topic of distillation?
TR: Ah, you see at our school now we are facing a challenge that our lab is not well equipped. Now we are trying to rely on things that are a bit of theoretical then from there we bring in things that we are doing in our houses. Like this topic of distillation, I always try to link it to their ways they brew their traditional alcohol here in the community. Because that one in science we can say that is distillation, because they normally use the same process of boiling contents and from there they collect alcohol that is the practical example of distillation. But now in real life here we are just using theoretical.
FQ: Maybe if you can specify to something, because you were just giving an example, may you specify the name of that traditional one with reference to distillation?
TR: The name of the process. That one I can just say its process of simple distillation that they use to make traditional home brew that we call Kashipembe. Because normally, we use to mix the mangetti fruit, then from there they crush it and then they put it to ferment a bit and put in the pot then from there starts boiling it. Then they connect the condenser where they use to fill water. Then that content will start boiling and alcohol will

drop off first before water. In other words, we are doing science in our community unknowingly.

IQ.6.: Are there some problems in general which Physical Science teachers are facing when teaching the topic distillation?
TR: Yah, the problems are there. As I said first we do not have materials and science is a practical subject whereby you have to do things and come up with results. And your results must be based on what you are seeing and not what other people knows in the past. The first challenge is lack of materials. And the other challenge is the community where we are now, you see most of the people they came with the believe that science is a difficult subject you see. When learners coming to your class with that believe you really need to work hard to break that bond of that believe that says science is very difficult. Otherwise we are trying our best learners are coping.

Thank you very much.

iii. Post-Interview Mr. Strong at Tushetekenu Secondary School

IQ: for Interview question. Mr. Strong: the science teacher FQ: for follow-up question

IQ.1.: Looking at the lessons you have presented, do you think you have considered learners everyday knowledge or everyday experiences when you were teaching those lessons on distillation?
Mr. Strong: "I considered their everyday knowledge by using examples that relate to everyday science matter".
FQ: May you please give me one of the examples which you can remember.
Mr. Strong: " one of the example is the sugar solution where you mix sugar and water, and then when you want to separate the two you can use evaporation as a technique".
IQ.2.: Do you think it was important to study the topic of distillation in the classroom like the way you taught these lessons?
Mr. Strong: "Yes, it was very important when it come to distillation. Yes, because distillation is also used in rural areas to brew alcohol and I also used that to related it to everyday use even though it is not encouraged that they should go and find the final product in rural areas which is alcohol itself'.
FQ: You just mentioned examples in rural areas, may be if you can give me examples of traditional brew which they can make in rural areas through the process of distillation.
Mr. Strong: "Yes, they call it Kashipembe, they use distillation to brew it".
IQ.3.: Looking at the lessons you have presented, what types of teaching strategies you used to teach this distillation lessons?
Mr. Strong: "I used centre, ah, learner-centred method were the learners do more than the teachers".
IQ.4.: Do you think lack of materials here have effects on teaching of distillation, what are your views?
Mr. Strong: "Yes, because they can't be practically see what we are talking about. But with these what we actually do is we substitute were we cannot find the apparatus. We substitute these with videos of certain processes".
IQ.5.: What went well in your lesson, and in your views what makes it to go on well?

Mr. Strong: "The lesson went on well, because the learners where listening when time came for listening. The learners were energetic maybe because they just came from the holiday. The other thing is that they participated and were more active. These make it to go well, because when it is learner-centred the learners should participate more than the teacher. And this is what has happened".

IQ.6.: Do you think there were some of the things which did not go well in the lessons?

Mr. Strong: I did not notice anything yet, I think the test will reveal what didn't go well. And from the test we have to go back and polish those which was not clear".

IQ.7.: What are your comments and suggestions regarding the presented lessons and the whole phase of this study since I came here?

Mr. Strong: I suggest that we actually don't limit them to ethanol and water when it comes to fractional distillation. We should also bring to them crude oil, petrol that we are using every day in our cars that they hear prices are rising is also separated using fractional distillation. And that there are other things obtained from using this like petroleum jelly, tar which we are using to construct roads and also on".

iv. Post –interview with Mr. Gaps at Yebo Secondary School

IQ: for interview question. MR. GAPS: the science teacher FQ: for follow-up question

IQ.1.: Do you think that you considered learners everyday knowledge when you presented the lessons on distillation?

MR. GAPS: Ya, I did. I did it when I was asking them to give their own practical examples in their local environment.

IQ.2.: Do you think it was important to study the topic of distillation in the classroom like we just did it with the learners?

MR. GAPS: Ya, it is very much important. Whatever we are doing at school we ensure that these learners should apply it in their environments. These are the educative things we are doing and knowing these learners will have good lives.

IQ.3.: Maybe looking at the lesson you have just presented, may you tell me what type of teaching strategies you have used?

MR. GAPS: The teaching strategy was learner centred. Whereby learners where given chance to give their views first so that learners should try something then from there you build up where they ended. Basically, that is learner centred approach.

IQ.4.: do you think that lack of materials have effect on the teaching of the topic distillation?

MR. GAPS: Obvious, as you see there we only used a poster. It could be more understandable to learners if it was to be hands on. Learners have to see what they are doing and know every step we are doing in real life situation so that they can try to put it in concrete things. So, materials are very important inn the teaching of distillation topic.

IQ.5.: Looking at your lessons in general, what do you think went well and what do you think did not go on well?

MR. GAPS: "Eh, what I can say went well there is that learners got an idea on the different between the two type of distillation; the simple and fractional distillation. That's what went well learners can tell the different between the two".

FQ: Maybe before you go there, what makes it for the learners to get the idea?

MR. GAPS: Eh, by looking at those two posters. This other one have columns, we talk of fractionating column for fractional distillation while the other one of simple distillation do not have that column.

FQ: Anything which did not go well?

MR. GAPS: for the things that i think which did not go well there is that some learners still have this misunderstanding of these concepts that we normally used. so, like when we came to **solution** how solution is being formed some learners find it difficult which solution is this one. They even failed to find out what are the substances which make up a certain solution. That were the things that I saw did not go well there.
IQ.6.: Now, in general what are your suggestion or recommendations with regard to lesson presentations and the whole face of the study.
MR. GAPS: I think for that thing to be properly done. I am suggesting of going to our TRC (teachers resources centre) now, so that we can try to get some materials if possible. If not then I will try to get a video so that they can see properly on how the stages and step use to be done during this type of distillations. I think those ones will be ok. Now we using like theoretical things but if we will bring things like a video will do better. Because they can see, it can also be repeated for them to see how the practical steps are being explained.

v. Three lesson observation Mr. Strong

T: for teacher
L: for one learner responding
LL: for more than two learners responding.
LLL: for the whole class responding
[ ]: for anything that is not said.

Classroom observation: Lesson 1. Video 1
Tushetekenu Secondary School 14/05/2014

T: Today we are going to continue with experimental techniques. Now I would find out if you have been reading. Or you just went home and closed your books until now. So, who is going to tell me what a **mixture** is? (**repeated it**). Ya, **Kasoma.**
L: two or more elements that are not chemical combined.
T: good. So we have different types of mixtures, isn't?
LLL: Yes sir
T: can you give me this different types of mixtures with an example?
LLL: [mummering]
T: Ya
L: sugar and water.
T: Sugar and water, What type of mixture is that? Ya

L: solid-liquid mixture e.g. salt and water and liquid-liquid mixture.
T: liquid-liquid mixture example?
LL : water and ethanol.
T : girls-girls ! [teacher writing on chalkboard]. Ya
L: Liquid-liquid mixture example water and oil.
T: Liquid-liquid mixture was mentioned already.
LL: solid-solid mixture.
T: Solid-solid mixture an example?
L: Salt and soil.
T: Ok. We go to the term **soluble**. Who is going to define the term soluble?
LLL: Learners were quiet and mummering.
T: [reframed the question] What does the term soluble mean?
L: Something that dissolve in liquid.
T: Ok. This is science, we don't use something.
L: Shouted substance.
T: Yes, **it is the ability of a substance whether liquid or solid to dissolve**. And then we go to **insoluble, insoluble. Kasoma?**
L: Substance that cannot dissolve.
T: Then, yes, **substance that cannot dissolve.** Condensation, yes.
L: Condensation?
T: Hmm.
L : When gas changes to liquid.
T: Yes, **condensation is the state where gas changes to liquid**. And what is **evaporation?** [the teacher pointed a learner]
L: Phase change of liquid to gas.
T: **Is a phase change of liquid to gas.** Boiling point. Ya, **boiling point**?
L: is a maximum rate of temperature of something...[learner still struggle to state the anser correctly] is a maximum temperature of boiling something.
T: Ok. Lets go through this, what happen when a liquid example water boils when heating it?
L: It changes from liquid to gas.
T: from liquid to gas. Ya, Ok. Lets start, lets start slowly. Eh, there ios water in the beaker and you are boiling this water, what happens?
L: Energy is transferred.
T: Energy is transferred from a heat source to the water, the water gains kinetic energy, Yes, isn't it? And from there what happens?
LLL: They move away from each other.
T: Yes, they move away from each other and then? [Teacher demonstrates movement with hands and paused]. Change of state occurs from liquid to gas. Now with this who is going to give me the definition of evaporation?
L: Is it not for boiling point?
T: Ya, I mean boiling point. Who is going to give me the definition of boiling point? Ya, lets try, lets try.
L: Is the maximum temperature when the water boils.
T: Ok, I want you to replace water with liquid eh. Because is not only water boils.
L: Is when a maximum temperature of liquid changes to gas.
T: Boiling point, yes she is in the right direction. Who is willing to try? Who is going to try the guys are mute now, what's going on? Ya.
L: When a liquid changes to gas at a maximum temperature.
T: Boiling point **is a maximum temperature at which a liquid, ah; state, or change of state occurs from liquid to gas.** Is it clear?

LLL: Yes sir. [No, other learners murmuring].
T: Who says no? [Teacher reframed the definition]. **It is a maximum temperature at which change of state occurs from liquid to gas.** You see when you are boiling water and it reaches 100 ^{0}C, that is the maximum temperature, and then it starts to boil. When it is boiling it attains kinetic energy, the molecules attains kinetic energy, bonds are broken and it changes from liquid to gas. What is **solvent**? [teacher writing definition on chalkboard].......solvent! The guys, the girls are beating you.
L: Is that substance that dissolves in water.
T: Ok. Solvent? Can we share your discussion? Your discussion is productive, so can we hear it? Ya [Teacher pointed to a learner].
L: Is any substance that allows other substance to dissolve in it. [Other learners still with hands rose up]
T: Yes. An example of solvent?
L: Water.
T: What will water dissolve?
L: Sugar. [Others murmuring; oros, salt]
T: [Teacher did not clearly define the term solvent for learners to take note of it] Miscible liquids, remember we spoke about miscible, ah, liquid, eh, different types of mixtures. Liquid-liquid mixtures. **Miscible liquids**? Can you give me an example of miscible liquid?
L: Coke and beer.
T: Yes, other examples?
L: water and alcohol.
T: Water and alcohol. So, now what is miscible? Miscible, who will be able to define the term miscible? Ya, we are waiting.
L: is the substance that can mix.
T: The definition? Can you give us a definition and speak louder. Definition of miscible.
L: Is something that can be mixed.
T: Hey, you are making noise in the corner there [Learners discussing holiday stories]! You are saying?
L: Substance that can be mixed.
T: Yes, **miscible is the ability of a substance to mix with another.** What is **immiscible substance**? Ok, lets start with the examples of immiscible substances. Ya.
L: Water and oil.
T: Water and oil. So, all of you only know about water and oil?
LLL: Yes, others No.
T: Hmm..! all of you know about water and oil (**repeated).** Ah!
L: Water and mercury.
T: Water and mercury. So, now who is going to give us the **term** of immiscible? Just the opposite of miscible. Guys? [All learners quiet for a period of time] Yes, [Pointed to a learner] You should speak a bit louder (**repeated**). Now, the girls over there your discussions are not being constructive.
L: These are liquid that does not allow other substance to dissolve.
T: Yes, Who wants to give it another try? You may have a seat. Yes, **Kasoma** do you want to try, I see your hand about to come out.
L: I just want to try.
T: Ya, so its good to try.
L: Substance that have the ability to dissolve with other subatance.
T: Ok. Its good that you have tried. Ok. Kalungungu.
L: are two substance which are impossible to mix.

T: Ok. **Immiscible, is the inability of a substance to mix with with another.** Are we clear?
LLL: Yes sir.
T: Is an inability of a substance to mix with another. Solution, what is a solution? An exampleof a solution is ah sugar solution, salt solution, so you guys keep on giving me these examples of solid-liquid mixture. So now, what is a solution? (**repeated the question)** I hear you guys giving me examples of sugar solution, salt solution and with reference to solid-liquid mixtures yah.
L: These are substance which dissolve in other substance.
T: Solvent?
L: No sir, solution.
T: Solution. Who wants to give it another try? [The teacher was walking around] Solution. Ya [teacher pointed to a learner]
L: Let me try, solvent is the substances that combine together.
T: Yes, you are on the right track, but can't we put it in science terms (**repeated).** Can you repeated your definition of solution [teacher pointed to a learner].
L: What I said first?
T: Yes.
L: Ok, these are substances that dissolve in other substance.
T: Hmm?
L: Substances that dissolves in other substance.
T: Substances.....
L: That dissolves in other substances.
T: ...That dissolves in other substances. And yours was? [Teacher pointed at a learner]
L: When dissolved substances are mix together.
T: Yours is much closer.
L: [murmuring, much closer?]
T: Yes. We spoke about a solvent, isn't?
LLL: Yes.
T: If you say, sugar solution we mean water and sugar isn't? A solvent is?
L: Water.
T: And the solute is sugar. So now from these two terms can you come up with the definition of solution? Ya [Teacher pointed at a learner]
L: are solid substance which dissolve in solvent.
T: Yes, **is when a solid dissolves in a solvent** that is a solution. **Distillate (repeated).**
L: [Learners murmuring distillation]
T: No, not distillation. Distillation is the process, distillate is the end product. An example of a distillate is distillated water [Instead of distilled water]. With these examples can you come up with the definition of distillate? [Teacher was walking around between groups]. So I am going to repeat what I have just said than from that you can build your definition. Distillation is the process and distillate is the end results. And example of distillate is distillated water and so now what is the definition of distillate? Ya, [Teacher pointed to a learner]
L: distillate is the product that we get at the end of distillation process.
T: You are right. Now the state of this product is very important in the definition. Is this product pure or impure?
L: How?
T: Is it pure or impure?
LL: Pure.
T: Pure. So can you start over with your definition.
L: Distillate is the pure product that we get at the end of the distillation process.

T: **Distillate is purified water example distillated water which is collected in a collector which can be a funnel at the end of distillation process**. Go to your hand-out and go to separating a solvent from a solution chapter 20. You can see that the end product of the distillation process is called distillate. In this case it is distillated water. Yes, on this page you can look at that diagram. The diagram with different apparatus of the distillation process. So let us recap on what we did. **We start off with mixture, which is a composition of two or more substance which can be element or compounds that are not chemically combined that is very important. You can have a mixture of sodium and potassium provided that they are not chemically combined. Once they are chemically combined they become a compound not a mixture anymore. Then we went to different types of mixtures. Solid – solid mixtures sand and sugar, liquid –liquid mixtures water and ethanol, liquid –solid mixture water and sand. Then definbe soluble, the ability of the substance to dissolve. Then we went on defining insoluble, the inability of the substance liquid or solid to dissolve. Condensation, there is something we call condenser isn't?**
LLL: Yes
T: So this process happens in the condenser. You guys do geography?
LLL: No.
T: But you did it last year in grade 10?
LLL: Yes.
T: So in the atmosphere where does condensation take place?
LLL: In the atmosphere.
T: You know that the clouds are the results of condensation?
LLL: Yes.
T: So, where does this process takes place? Artificially we use condenser. Naturally!
T: The atmosphere is divided into different layers.
LLL: Yes.
T: Ok, that will be your homework. Go and look for Mr. Mbwaku or Mr. Kauhano. And do you know about condensed milk?
LLL: Yes.
T: How do you think this milk was made?
LLL: It was condensed.
T: It was condensed?
LLL: Yes
T: Condensed milk, **condensation is the state of change from gas to liquid.** Can we put down something?
LLL: No.
T: Take out your exercise books.
LLL:Monday
T:no no no, we do not have time to waste.
LLL: [learners just making noise]
T: [Teacher writing on chalkboard learners where still making noise]

Classroom observation: Lesson 2. Video 2
Tushetekenu Secondary School 15/05/2014
T: [teacher just started writing on the chalkboard for learners to copy]
LLL: [Learners were busy writing the notes based on what was presented.
LLL: Hey-hey! [learners making noise]
T: [writing on the chalkboard]
L: [coughing while writing the notes]

T: So, ah, distillate we can say that it is the end product of distillation. Distillation is a process. Now how do we know? Who can actually outline the steps of distillation?
LLL: [Quiete]
T: With reference to the apparatus. Set your eyes on apparatus. On top there is written chapter 20 as the topic. Experimental techniques letter C.(i). The apparatus on c.(i). Now these apparatus are the ones used in the distillation process. Lets start with the heat source. Why do we need a heat source?
LLL: [still quiet]
T: Ya, i am talking to you guys. Why do we need a heat source in the process of distillation? Ok, lets put it this way which properties of an element do we consider when we are using distillation? [Pointed at a learner]
L: Boiling point
T: Who wants to try? Properties of the mixture when you want to..Which properties of the mixture do you consider when you want to use the process of distillation?
L: Boiling point
T: She was right. Boiling point. Different boiling points **[repeated]**. Tom, why do we need a heat source? Who wants to try, why do we need a heat source? Ya [Pointed at a learner]
L: To separate the substances like the ones that have different boiling points.
T: ya, we need the heat source for us to attain the different boiling points. Is it clear? We need the heat source in order for us to attain the different boiling points. Without the heat we wouldn't have attain the different boiling points. And a thermometer, why do we need it? Ya.
L: We need it to take the temperature.
T: Temperature, Why do we need to take temperatures with this apparatus? I mean in this process. Ya.
L: To find the boiling temperature of substances.
T: Ya, to find the..
L: To find the boiling point of substances.
T: Ok, he is right. Since we said that the properties we are looking for here is the boiling point we need to know the temperatures, the boiling temperature. Isn't?
LLL: Yes sir.
T: And the condenser, the condenser? Ya.
L: It cools down the substances or the steam.
T: It cools down the substance that was changed to vapour. [pointed at a learner]
L: It changes changes gas to liquid.
T: It changes gas to liquid. Now, who can tell us that, why the condenser was designed in a such away that, the water inlet is at the bottom and the outlet at the top? [write on the chalkboard] why was it design in that way? **Why didn't they put outlet at the bottom and the inlet at the top?**
LLL: [Murmuring]
T: Ya. Who has an idea? Ok, let me [write on chalkboard: drawing part of the condenser]... Monica and who?
LLL: Monica and Maria
T: Monica and Maria, Monica is at the bottom and Maria is on top. Lets say this is 5 metres. Who will complete the 5 m the first?
LLL: Chorus No one.
T: Who will complete the metres first?
LLL: Ma, Ma, Ma.
T: Maria will complete it first because she is going downhill.
LLL: Chorus, Yes.

T: If in the race of money this would be an advantage. **But we don't need the water to go into the condenser as fast as possible. We want it to spend much time in the condenser for much cooling, for better cooling. That is why the inlet is at the bottom and the outlet at the top.Its clear?**
LLL: Yes.
T: The water coming from the bottom takes time to exit hence better cooling. But if it was coming in from the top it will move out very fast and the cooling will be inefficient. Is it clear?
LLL: Yes sir
T: So, who is willing to tell us or brief us on the distillation process. Lets use the salt solution [**repeated].** Hmm. Salt solution, the distillation process using the salt solution. Yes **Kasoma.**
L: First the solution is boiled, then it changes to vapour and then the vapour is condensed in the condenser, when vapour pass through condenser it will be condensed up and in return it changes to vapour, and the vapour changes to water and be collected in the receiver. And in the flask the salt will be left in.
T: Very good. I could not explain it better myself.
LLL: Not clear.
T: Not clear, can you repeat it?
L: Yes sir. Firstly, the solution is boiled after being boiled it changes to vapour. The vapour is passed through the condenser and the vapour will be cooled and changes to liquid which will be received in the receiver. And in the flask the salt will remain.
T: Yes. What evaporates is the solvent, eh! The solute remains behind. The solvent get trapped in the condenser and be cooled and get back to liquid. Then it drips down into the flask receiver where you find pure liquid. In this case it will be **distilled water**. So, let me see if the boys were listening.
L: Me sir.
T: Stand up. Outline the distillation process [**repeated].**
L: When a solution is heated in the distilled glass the solvent evaporates. As it evaporates the vapour in the condenser condenses and cooled. And changes to liquid which is received in the receiver.
T: And the liquid in the receiver is called what?
L: distilled or distillated water.
T: Good. Those are the distillations, that are the distillation process. That is the distillation process. Now without looking into your books i want you to give me the apparatus. Name the apparatus. Close your books! Ya, [pointed at a learner].
L: Condenser.
T: Condenser.[pointed to a learner]
L: Thermometer.
T: Yes, thermometer. [pointed at another learner]. Ya.
L: Receiver.
T: Receiver. Ya[pointed at a learner].
L: Bunsen burner.
T: Bunsen burner. [pointed at a learner]
L: Distillation flask.
T: distillation flask. Whatelse?[**repeated**]. Yes.
L: **filter paper.**
T: You know it is very,... when separating solid-liquid mixtures it is easy to use distillation. But now when it comes to liquid-liquid mixtures what happens? Evaporation takes place at a any temperature. Isn't it?
LLL: Yes.

T: If you try to separate a solution of ethanol and water what can you do? Remember evaporation takes place at any temperature. And what is the definition of evaporation? Change of state from....?
LLL: Chorus liquid to gas.
T: Liquid to gas. Meaning both will change states at same temperature. That will evaporate will condense and at the end of the process you will won't get pure ethanol or purified ethanol. Because water will also be in that ethanol. At the end of the day we will end up getting a mixture. This is were **fractional distillation comes in.** It is the same they use the same apparatus. But now there will be a different of addition of **fractionating column.** The fractionating column contains beads, glass beads. So when you heat your mixture they will all evaporates at once. Ethanol and water will evaporate. **When they reach the fractionating column the beads condensed these two liquids. Now they reach different boiling points, ethanol at 78 ^{0}C and water 100 ^{0}C**. Now what you have to do is watch your thermometer. Before you start boiling and while you are boiling. When water and ethanol will evaporates and condensed at the beads, glass beads, the temperature will again rise. The temperature of the beads will rise to 78 degree Celsius. At this point the ethanol boils off it goes into the condenser, its condensed. Change of state from gas to liquid and then it drips off leaving the water behind in the fractionating column. It drips into the receiver. But once the temperature increases from 78 degree Celsius then you have to switch off the Bunsen burner. Meaning the ethanol has been all evaporated. Simple as that, simple process with an introduction of a fractionating column. Guys you are very quiet and mute.
LLL: Listening.
T: Listening?
LLL: Yes.
T: Oh. It's good that you are listening neh [teacher was arranging other handouts]. So, who wants to repeat what i have said? Hmm?
LLL: To use ethanol?
T: Yes, you can use ethanol and water or what you are comfortable with. You should also mention the boiling point in your explanation. From the heating source, to the condenser to the fractioning column up to the receiver. Can you outline the steps again to the class.
L: Fractional distillation. The solution is like when you condensed water and salt. The solution first is hheated up and the water collected is mostly ethanol and steam. It rises up and....! firstly you have to focus on the thermometer, if, when the steam and ethanol rises up, maybe ok, when the thermometer is rated at 78 degree Celsius that is the temperature of ethanol. It will pass through the condenser and it will be cooled down. Then ethanol liquid or solution of ethanol liquid will be collected at the receiver. and after a period of time the temperature will changes from 78 degrees upwards. First you must switch off. Then if you want to collect the solution of water at the same time you just change the receiver. And you have to wait for the boiling point of water to come which is 100 degrees and it passes through the condenser and its also put in the same process as the ethanol and you collect pure water.
T: Very good. Thank you very much read your notes and will meet you to recap on what we did today.

Classroom observation: Lesson 3. Video 3
Tushetekenu Secondary School 16/05/2014
T : Class I believe that you are in the science class neh.
LLL: Yes sir.
T: scientists they don't make noise.
LLL: Yes.

T: Scientist make noise with books and paper even when doing practicals. Because when you make noise you end up burning the laboratory. You better read your books now.
LLL: Thank you sir.

T: Good afternoon class.
LLL: Good afternoon sir.
T: Are you full of energy?
LLL: Yes sir.
T: That is a quiz [teacher distributing handout of quiz to learners].
L: Quiz?
T: Yes, is that difficult? There is nothing difficult. Lets share.
L: Sir my pen is lost.
T: Your pen is lost. It is a multiple choice quiz. Eh, its a multiple choice quiz. You write your name on the paper and answer on the paper. You guys are 48 how come I am getting thirty something?
LLL: Some are absent.
T: Some are absent. Class rap I need all the names of those who are absent. Ok, let me and get the rest of the papers ok.
LLL: Yes sir.
T: Lets do this quietly, let us not make a noise. [a learner knocking at the door] Yes, do you belong to this class.
L: Yes.
T: OH, OK. Welcome. Ask your friend what happened to them today for coming late to my class yah. And you should dress up properly. If you don't dress up properly you will not enter my class.
LLL: [Writing the quiz and some learners making noise in their groups]
T: Go to question number six. You don't have somewhere to click. Neh.
LLL: Yes.
T: Just ignore that one I have got nowhere to click just write. So you just read the question and answer either A, B, C or D.
L: We did not get papers.
T: I believe its an individual work
LLL: Yes sir.
T: Ya, you better don't talk.
LLL: [Writing the quiz]
T: Let us not discuss, lets do it individually.
LLL: [Learners were discussing silently while doing the work]
T: You are going to get something like this.[showing the extra handout of quiz to learners]. You are supposed to be having four.
L: Four?
T: Yes, one, two, three, four. Ok, let me get for you this one then.
L: I have the same copies.
T: Just send them back. The ones with blank behind should come back. Blank behing I want those ones back. Ok, question twelve will be a problem because it is cut. Question twelve continues on the other side of that paper. So you can just leave it because it will give you problems. Supposed to be on one page then you understands it.
L: Thank you sir.
T: Leave twelve out.
LLL: Yes.
T: Letter?

L: Letter B.
T : You got it already. The B is there. Ok, redistribute this better [showing a paper to the learners]. You guys have this one?
LLL: No. You did not give us.
T: Oh, I did not give you.
LLL: Yes.
T: Ok.
LLL: [Writing the quiz activity] Sir are we allowed to look in the books?
T: Ya you can. Can I have the extra papers [showing the learners a paper]
LLL: [learners where discussing in local or mother tongue while writing]
T: Can you minimize your noise? Halo can you minimize your noise.
L: Yes. [one learners was walking around to steple the quiz papers]
T: If you continue making noise you are not going to leave my class. The sooner you keep quiet the sooner you go home. And remember my class does not have chairs and you will be sitting on the floor.
LLL: [murmuring and laughing in vernacular]

vi. Three lesson observation Mr. Gaps

Classroom observation: Lesson 1. Video 1
Yebo Secondary School 01/07/2014T:
T:Good morning class.
LLL: Good morning sir.
[Both teacher and learners made a mistake of morning instead of afternoon]
T: How are you this afternoon?
LLL: We are fine and how are you sir.
T: I am fine. Let us start with the work of this afternoon. I want you to be in groups. And you must not forget to write your name on the paper in your group.
LLL: Yes sir. [Distributing papers for each group]
T: Alright, those papers don't write anything on those papers. Don't scratch, we are just using it to see whether our answers are correct or wrong. [Teacher still walking around while distributing papers]. So have seven groups we must remain with seven groups as such. We are looking at definitions which we normally use in science especially distillation. The first substance that we are looking for is a mixture. **What is a mixture?**
L: A substance that contains more than one substance.
T: A substance that contains more than one substance, eh.
LLL: Yes.
T: Alright, thank you very much. Someone else? You are making noise [some learners are playing in the classroom] Annastacia.
L: A physical combination of two or more substances.
T: Yes, you are right. Kambinda?
L: Is a substance made up of more than one substance that is not chemically combined.
T: Looking at all the answers you are almost there. The answer that I wanted is **a composition of different substances; it can be a solid and solid; a liquid and liquid or liquid and gases**. **But must not be chemical, it must be temporary mixed.What is soluble**?
L: These are substances which can dissolve in water.
T: Substances that can dissolve in water. Soluble are substance that can dissolve in water Masonde?
L: Substance that dissolve in water.
T: Ok, Heke? [Pointing at a learner]

L: substance that dissolve in liquid.
T: Ok. Someone else? Ok. The word soluble is a very simple thing, because.... is something there?
L: Yes.
T: Ok. Read it.
L: Substances that is able to dissolve in a solvent.
T: Very good. The simple word there **is to be able to dissolve in a solvent. Not necessarily to dissolve in water only. Anything that can dissolve in any liquid neh. For example; if you take sugar and add it with water, after stirring in you find that sugar disappeared eh?**
L: Yes.
T: So, we say that the sugar dissolved. Now when sugar dissolved we say sugar is soluble in water, because it can dissolve in water. **In short we say soluble means to dissolve in something or in a solvent.** Then, **insoluble**? Is just the opposite neh?
LLL: Yes.
T: Who will try to get the answer right there? Can you just say the opposite of what you have just said now? Ndara?
L: ability of substances that do not dissolve.
T: Simple. **The inability of the substance not to dissolve in a solvent**. for example; if you have got sand, you know sand?
LLL: Yes [Others said Yii code switched]
T: Is sand and soil are the same? Sand and the soil are they the same?
LLL: No, some Yes.
T: They are not. [pointing at learners]. Alright, sand is the small grains and soil is the mixture of this sand. So, insoluble **means it cannot dissolve in solvent for example when sand is put in water.**No matter how you stir and do what the sand will never dissolve eh.
LLL: Yes.
T: So, we say it is insoluble. Eh, **distillation**. **what is distillation?** [repeated]
L: [The first answer comes from our group; a learner talking]
T: The first answer should come from where?
LLL: Here.
T: Ok.
L: The process of boiling liquid and collecting the vapour as liquid.
T: Very good answer. Very correct. I think you stole my answer Eh!
L: Yes.
T: Which group is that one? The group which gave me that answer.
L: It's our group [While laughing].
T: Another idea apart from that one? Another idea? The same answer?
LLL: Yes.
T: So it's correct. We say it **is the process of boiling a liquid and then condensing the vapour to convert it back to liquid.** And it's a process used to separate mixtures. When you are boiling something the water starts to evaporate neh?
L: Yes.
T: If you put something cold there you will see water again starting to cool down. Eyi, you are making noise. **Simple distillation?** Repeated it again. Hellena?
L: If you want to obtain a solute from the solvent the process is distillation.
T: If you want to obtain a solute from the solvent the process is distillation?
L: Yes.
T: Ok. Right. Eh, any group which did not say anything? Which group?
L: obtaining solute from the solvent.

T: Is just the same like when you obtain a solute from solvent neh. **The simple separation of a solid by evaporating a liquid and collecting it after it passes through the condenser to be changed into a liquid state again.** Which means if you mix two things one is a solid and the other is a liquid? For example you have got a salt and water and you mix them, salt dissolves neh.
LLL: Yes.
T: But if you want to get your salt back again what you have to do is you just heat up the mixture and water will start evaporating is that clear. And when water will start evaporating the white crystal remains back which the salt. That is how we do it. To separate a solid and a liquid, listen here Sarah! Why are you excited?
LLL: [Other learners laughing]
T: Why are you so excited? Your eyes are just this side, what is this side?
LLL: [Kept on laughing even louder]
T: Ok, we are saying if you want to separate two things a solid and a liquid, what you have to do is you mix them. For example; we used salt and water. And if you want to get your salt back just try to boil that solution then from there the water will evaporate out and the salt will remain in that **thing** and you can still collect it out. Then **Fractional distillation** anyone to define this one? Nguuru? You are making noise from Nguuru, Kalimbwe.
L: process of separating two liquids with different boiling points.
T: If liquid they are what?
L: If two liquids are miscible they must be separated by fractional distillation.
T: So, let's look at it in this way. If you look at these two how can they be separated? On simple distillation we are saying that is the method which we use to separate solid and liquid neh.
LL: Yes.
T: But, in this case now is fractional distillation they are all liquids we mixed them together. Now how do we separate them? So, we use this method because each liquid have its own boiling point. We will look at the boiling point later on. So you boil the two liquids, they are all mixed. Now how do we separate them? You boil all of them. Therefore it boils at its own temperature. Bring my chalk. Each liquid will boil at its own temperature. For example; how do you make alcohol at home? This drinks you are making from mangetti.
L: Kashipembe.
T: Ehe. Do you know how to make it?
L: Yes.
T: something is mixed with solid things and water eh.
LLL: Yes.
T: There is solid things inside there plus water they are mixed together but now; we want to take out alcohol called Kashipembe. How do we do it? You boil it neh.
LLL: Yes.
T: Then from there the alcohol called Kashipembe will evaporate. And pass through that tube and we use to put water there is that clear?
LLL: Yes sir.
T: Momuyengo Eh [Code switched]. Now in the pipe where you are putting water in science we called it a condenser. Because that water will be cold neh. The thing that you is evaporating from the pot is very hot neh, when it reaches that muyengo there its cold then it starts condensing there and changes into water, from there the Kashipembe will be collected in the other part. So we are doing science at home without knowing that that is science you are doing. So that muyengo we call it a condenser in science because it's the one that use to cool things down. And then, **condensation**? Repeated again.
L: The change of state from gas to liquid.

T: The change of what?
L: The change of state from gas to liquid.
T: Ok. We know already when you are heating a liquid it evaporating. Therefore if it cools down it becomes a liquid. That **process whereby a gas changes to liquid**. **Evaporation?**
L: the process of change of state from a liquid to gas.
T: The process of change of state from a liquid to gas neh. You can just say that evaporation is the opposite of condensation. **So, when a liquid changes to gas we call it evaporation. Distillate.** What is a distillate? Repeated. Not distillation but distillate. Are you hearing him there?
LLL: No.
T: When you read and talk you must talk to everybody is that clear.
LLL: Yes sir.
T: Edward, talk to everybody. Yes.
L: Is pure water which collects.
T: Is pure water which collects?
L: Yes.
T: Where? Where? Where? That answer is not complete it's incomplete. Someone with a different answer distillate is what? Ah?
L: The pure water which is collected is called distillate.
T: The pure water which is collect is called distillate? What is a distillate? That is what I am looking for.
L: Sir ahara kumona [a learner code switched].
T: Yes Masonde.
L: It is the process used to separate liquid.
T: Not really. Alright.
L: Is the solvent you can get.
T: Distillate, distillate is very simple people. Distillate, listen here we are doing science here. Listen here. We said when you are heating the water it what? It evaporates neh?
LLL: Yes.
T: So, if you put a condenser here [Teacher pointing on the diagram on the poster]. If you put a condenser there, water will be heated here it evaporates and it passes here. When we put a condenser here (we call it muyengo), when it reaches here it does what?
LLL: It condenses.
T: It will condense ah. When it condenses it changes to......
L: To liquid.
T: To liquid stage neh. Now when it comes to a liquid stage it passes as a liquid neh.
LL: Yes.
T: The one that we are collecting here [Teacher demonstrating by showing learners on the diagram] we call it a distillate. So, what is a distillate? The one that we are collecting is called a what? What is a distillate? Because we did something here starts evaporating when it reaches the condenser it start changing to liquid then from there it drips down here. Now what we are collecting here we call it a distillate. Now the problem is what is a distillate?
L: Pure liquid.
T: Very good, your answer is correct. It is very correct. We say **distillate is a purified liquid which is collected in a receiver during distillation.** That is a purified liquid that is collected during process of distillation. Eh, **miscible,** miscible? Repeated. Hey you are making noise. Yes Annastacia.
L: When two liquids which are mixed together they are called miscible.

T: Alright. In short. **Miscible means two liquids that can mix together is that clear.** Two liquids that are added together and completely mix, then we say they are miscible. Miscible means you can mix them eh?
L: Yes.
T: But there must always be liquid then you add them together. Then, if they can mix we say those two liquids are miscible. Immiscible?
L: It is opposite.
T: It's opposite neh.
L: Yes.
T: What is the opposite of miscible? Sindimba. With miscible we say two liquids that can mix together. What about immiscible? You can use your common sense now here. We say miscible means two liquids which can be mixed together. If you add them they will completely mix. Now, immiscible means the opposite of miscible.
L: Sir. [A learner calling a teacher to answer the question].
T: Who will try? Edward?
L: two liquids which cannot mix each other.
T: Two liquids which cannot mix with each other neh. **This are two liquids which cannot mix eh.**
LLL: Yes.
T: Who can give us an example that we know? Who cannot give me any two liquids that we that cannot mix? Who can give us a nice example that we know, we know them in our houses.
L: Sir me. [A learner eager to answer while rising up the hand]
T: Who can give me two examples that we know if we add them together they cannot mix. We know them in our houses. Two liquids if we mix them together they never mix. You will see them one part on top the other under.
LL: [Murmuring in the group oil]
T: Ah?
L: Cooking oil and water.
T: Are you hearing there?
LLL: No.
T: Cooking oil and what....?
L: Water.
T: If you try to mix them together no matter how you shake them and let it to cool down you will see one on top eh?
LLL: Yes.
T: And the other one will be?
LLL: Under.
T: Normally, which use to be on top?
LLL: Oil.
T: Oil, neh. That's why we use to say those liquids are immiscible. It means they cannot mix even if you shake them they will mix temporary but if you leave them again you will see the oil coming up again. So, we say they are immiscible. Solution, solution, what is a solution? Sivava? Stand up. Keep quiet.
L: Is often hard to say something is a mixture.
T: Is often it's hard to say something is a mixture?
L: Yes.
T: Can we go to a solution. What is a solution? Something that we call a solution. What is that thing? [Learners rose up hands but teacher is not pointing one]. Elisa.
L: a mixture that dissolve in water.
T: A mixture that dissolve in water, you are in the track. Yes.

L: Substance that dissolve in liquid.
T: Substance that dissolve in liquids. So, it's a solution.
L: No.
T: Eh? I needed a solution. What is a solution by the way? Christine
L: The mixture of dissolving salt and water is a solution.
T: The mixture of dissolving salt and water is a solution.
L: Yes.
T: You are in the right track. There someone who just said that. **A solution is a mixture of a solvent and a solute. E.g. Solvent + solute ⟶ solution.** So, we say a mixture of solvent and a solute. Is that clear.
LLL: Yes sir.
T: the last answer you say is a mixture of a solute and a solvent neh. If you mix these two things you get a solution eh. **Boiling point, boiling point?** Repeated four times. Eh. What are you doing Ndumba? Boiling point is what?
L: The best temperature that a gas created above the liquid equals the atmospheric point.
T: So, there is something missing in that answer. In the answer Ndumba was reading there is something was missing.
L: The temperature at which the pressure of the gas created above the liquid equals to atmospheric point.
T: Atmospheric point? Eh! Is equals to atmospheric point?
L: Yes.
T: Not really. Something again is missing. Andreas. Boiling point, boiling point? Let's listen from others.
L: The temperature of the gas equals atmospheric pressure.
T: So, in short we can just say, **boiling point is a highest temperature at which a substance can change its state from a liquid to a gas. A highest temperature whereby a substance changes its state from a solid or a liquid into a gas.** That is the boiling point. And the last term that we look at is **solvent** eh? Solvent, what is a solvent? solvent? we did not include solvent/
LLL: Yes.
T: Solvent, it was there.
LLL: No [Chorus]
T: alright, let's look at this it's on the chalkboard. If you add it there, solvent is this one neh. We are saying; solute, if you mix solvent and solute you get a solution.
L: Yes.
T: For example; a solvent for example I can add water here and then example of a solute s salt. Now let's look at these things now, don't just add it there [water + salt ⟶........ let's make this who can give the answer there? water is example of a solvent and salt is example of a solute. Now what is a solvent? we are saying salt is a solute and water is a solvent. now, what is a solvent?
L: Sir let me try.
T: And if you mix these two things you make a solution [Teachers was pointing to words on the chalkboard]. Jonas.
L: When you add solution and solvent then you get a solute.
T: What we are looking for is this word [Teacher pointing to the word solvent on chalkboard]. What does it mean?
L: Sir let me try.
T: Yes.
L: Solvent is the mixture of water and salt to make a solution.

T: We are not asking how you can get a solvent. listen here try to answer the question run away from the question. What I am asking here is what is a solvent I am not asking how can you form a solution. Ok, Disho.
L: is a liquid in which solute dissolve.
T: Very good eh. We can say any substance whereby other substance also dissolves. For example, this water if you add this one, salt will dissolve neh.
LLL: Yes.
T: Which means **a substance that dissolve other things we call it a solvent.** For example water is a solvent, why do we say water is a solvent because when you add salt into it salt will dissolve eh. If you add salt in it the salt also will dissolve. So, **water is called a solvent and something that dissolve in it we call it a solute.** Is that clear here?
LLL: Yes sir.
T: Good. May I have my papers? Bring my papers here. Wait, wait I will tell you what to do again.

Classroom observation: Lesson 2. Video 2
Yebo Secondary School 02/07/2014

[No greeting took place]
T: There is a group there?
L: Yes.
T: Ok. [Teacher busy distributing papers amongst the groups]. So, we can remember to in our groups today eh. Lesson 2 eh.
L: Yes.
T: Last time we looked at definitions.
L: Yes.
T: If you forgot those definitions is up to you. Because after these I will give you questions that you will answer again without checking in any book. If you forgot what we wrote last time on definition today I will see.
LL: Nan, Sir!
T: Yes. That is it serious. Alright they are very simple things as long as you are going to listen to what we are doing today then it will be fine. Then, tomorrow I will reward the first group neh. Is that clear. Alright. [Teacher displaying a poster on the chalkboard]. So, we are using this diagram here on chalkboard or poster that one of us drew in order to explain........... Oh! This is useless check in the storeroom there are big magnets there these are useless. I thought they are strong. They are weak.
L: They are weak like Mahupe.
T: They are weak like what?
L: Like Mahupe oh.
T: [Teacher laughed] is Mahupe weak?
L: No, he is Strong nah.
T: While we are waiting for someone to bring the magnet try to read those notes there. That's were we are going to pick our discussion there we look at the thing here. And I will give you questions that you should answer. First, what we are discussing now. If you won't listen your group will get less marks. And don't forget we are only rewarding the best group. The best group or the best two. The best group or the best two?
LLL: Two.
T: Very good. This is the one now. Ok. We are looking at the simple distillation eh? We are busy looking at the process that is involved in the process of distillation. Today we are

looking at simple distillation that is our lesson for today. We are looking for description of distillation processes. What normally use to happen during the process of distillation? Distillation we said it is a simple method which we use when we are separating simple things like for example a solid and a liquid. Now looking at our notes there how to separate a solvent from a solution? What is a solvent again? Who can remember what a solvent is again? Solvent? What is a solvent eh? A solvent any person. If you have got a solvent and a solute you combine them you get a solution. Yes try.
L: A mixture of two liquid.
T: A mixture of two liquids. Not really. Solvent, for example you must have a solvent + solute $\longrightarrow$ solution. The problem is what is the solvent? Repeated. Example of a solvent is water and example of a solute is sugar either salt, then you will get sugar solution. Then, what is a solvent? A substance in which what......? Yes Disho.
L: ......in which a solute dissolves.
T: Very good eh. **Is a liquid or substance in which other substance can dissolve. Because we have sugar and water, sugar will dissolve neh?**
LLL: Yes.
T: Yes, sugar can dissolve. We can say a solvent is a liquid in which any substance can dissolve. Then, the following happens in the process of distillation; the solution is heated, for example we have the solution of sugar and water. If we look at our papers we have salt and water neh. If we mix them how do we separate these things? Because we have salt solution now, how do we separate the two things? The first thing we say the solution need to be heated neh? How do we heat things by using what?
L: Heat
T: How do we use heat? By using what? When heating something what are you seeing? Repeated.
L: Fire.
T: Fire or heat neh. That is it. You can see it here source of heat must be there. Ok, now, for example this is our round bottom flask here and these are salt water neh?
L: Yes.
T: Which means there is water and salt mixed together. Now, if you want to separate them, because you put salt in water they completely mixed neh?
L: Yes
T: Now, how will you separate them? Now we use to separate them through the process we call simple distillation. How do we do it? First thing is we must heat them, how can we heat them we must put it under the fire eh? Then from there when you heat these liquid what will happen? What do you think what will happen?
L: It will boil.
T: Starts boiling eh?
L: Yes.
T: From boiling it does what?
LLL: It start evaporating [Chorus]
T: One person. From boiling, when you heat a liquid what happens?
L: Boiling.
T: It starts boiling eh? From boiling it stops at boiling?
L: No.
T: What will happen? You rise up your hand if you want to say something not singing like in the church ah?
L: It starts evaporating.
T: It starts evaporating ah?
LLL: Yes.

T: That is the logic behind here. So, when you heat a liquid the liquid will start evaporating eh?
LLL: Yes.
T: When it evaporates it moves up here. Don't forget that this part [Teacher pointing on the displayed diagram of simple distillation] is closed completely closed. Therefore, after evaporating it must pass through here [pointing on the chart] and this one we call it a condenser. A condenser, when we are doing Kashipembe that muyengo we put water in neh?
L: Yes
T: For cool water to cool it. So, when this air is hot it starts evaporating. When it reaches a cool place it starts condensing is that clear.
LLL: Yes sir.
T: When liquid is condensing, when something is condensing what happens to it? When a gas is condensing what happens to it?
L: It will start evaporating.
T: Because when you start heat liquid, it starts evaporating when it reach there and it starts condensing then call it what, condensation. Then you say condensation has taken place. That's why we are talking of condensed milk that is too condensed. Now, when the gas is condensed what happens to it? It's changing from what to what? When a gas is condensing or when a substance is condensing it changes from what state to what state?
LLL: [They gave chorus answer]
T: One person, one person rise up your hand if you want to say the answer. Kangudi.
L: It changes from gas to liquid.
T: Exactly. That is what is happening. When you heat a liquid here it starts evaporating, when it starts evaporating it's in the form of gas. It is in the form of gas, the it passes here this place is the condenser [Teacher shows the learners by pointing at the diagram of simple [le distillation] it is very cold because of the water that they put in. Therefore, it changes from gas to liquid. Now when it come to a liquid it starts now dripping here [Teacher demonstrate on diagram to show the learners how it drips into a receiver] is that clear.
LLL: Yes.
T: What is to drip?
L: Kuzoza [A learner code switched]
T: As you can see it here, at first is just a gas that evaporated now when it reaches here into a condenser here [Teachers still show by pointing at the diagram on the chalkboard] the gas will change into a liquid. Then it just the from there it drips off there. Then what do we get?
LLL: Pure water.
T: Pure water neh?
LLL: Yes.
T: What do you think will be left inside? The water will evaporate and gas condenses the water drips of neh?
L: Yes.
T: Now, what thing that will be left behind there? What will be left? Because when you heat the whole solution the water will evaporate. Then, what do you think that will happen? Nekaro.
L: Salt will be left.
T: Salt will be left, is that clear? A salt will remain behind and only water that will be evaporating. Now in that case we can still separate the solution and get our salt back. Because when we heat all water will start evaporating and the salt will be left behind. The salt will remain here and the water that will be dripping will be here [Teacher showing learners on the diagram on chalkboard]. How do we call that water here [Teacher pointing at the receiver]? A

special name given to something that you are collecting after distillation. How do we call it? Repeated. It starts with a D. Ok, Yes.
L: Distillate.
T: Distillate eh?
L: Yes.
T: Distillate is what we received here everything will be called what distilled water. The liquid is called distillate. If you check on our paper that we are having there there is something there [Pointing at condenser]. how do we call it? The whole thing there is what? You don't have eyes, this whole thing here. This whole thing how do we call it? Kambinda Nguuru?
L: Cool water.
T: Cool water?
L: Yes.
T: No. Hey, Nguuru. Check here the answer is here. That is why I am saying the answer is here. Now the simple thing here what is here? What is the role of the condenser? I said if you don't listen you will not get it correct. What do you think the role of the condenser? Ok Jonas.
L: For cooling water.
T: For cooling water?
L: Yes, to cool water.
T: To cool? Which water?
L: To cool down the water
T: If you can check at the condenser, there is water in and water out.
L: Yes.
T: And you are saying to the water which water? Condenser?
L: To cooling water out.
T: To cooling water out, no. Condenser?
L: For cooling water in.
T: No. Condenser, condenser? What is the role of it?
L: To cool water in and out.
T: To cool water in and out?
L: Yes.
T: Disho?
L: To cool down the heat.
T: Eh, to cool down the heat? No. People that's the things you can see here. It's even written there on your notes. The role of the condenser what does it use to do?
L: To cool down the gas.
T: To cool down the gas? Out of two I will give you one mark. Hellena.
L: To water in it.
T: excuse me?
L: To water in it.
T: To water in it No. We are looking at the condenser what does it use to do? You see, the things is..... Listen here, hallo listen here. We say this is heat neh?
LLL: Yes.
T: Then we heat our salt solution then the water starts evaporating and then what? From there it will pass here?
LLL: Yes
T: What happens from there? What is the role of a condenser? This thing here [Teacher pointing at a condenser on a poster] what does it use to do?
L: It condenses the water.
T: Which water, which water?

L: To condense the evaporation water.
T: Not evaporation but evaporated water neh.
L: Yes sir.
T: Very good. Listen here, the function of this thing in order to condense this water. When you heat water, it evaporates and now water is in the form of the gas neh?
L: Yes.
T: Now which means when it reaches here this place is very cold, now this evaporated water will be changed into a liquid form. That's the function of it. Eh, let's try to recap on this. We are saying the solution is heated in the glass as we said. It boils and steam rises into the condenser, the salt is left behind in the flask. Now we say when you heat the solution the water will start evaporating and what is left here is the salt. To be left behind this is a flask [Teacher pointing at a diagram of a flask on poster]. So, then the condenser is cold, the steam which is hot will condense. It means when the steam is condensing it is changing from gas to.....
L: To liquid.
T: So, when it changes to liquid here then it starts dripping one by one. Ngwe momu avaninki Kashipembe ah [Teacher code switched] that's how it use to happen. That alcohol use to come from the pot. The pot that we normally heat. And that condenser that we call muyengo [Teacher code switched] there is water in there. So, that gas evaporating from that pot when it passes through that pipe start condensing at the end the Kashipembe will drop out there. You see what we are doing now we are doing science. So, we say the water drips into the beaker; it's now called pure distilled water. This method can also be used to obtain pure water from sea water or even from ink. You can mix ink with pure water at the end we can still separate them and we can get the water again. You know ink? Even dye we just add on water and if we want the water back we can just carryout this process and we get the water back. And it can even be drinking it again. Eh, simple distillation makes thousands of products possible from white vinegar to extra and extra Vitim Olive Oil to Vodka. Who knows Vodka? Is a special type of alcohol, it's so expensive. It is only for man. For man means only for strong ones, because the contents is very concentrated. Eh, you are making noise. What did we say the solvent? What is the solvent again? Solvent? Repeated it several times, nothing?
L: Is a liquid in which other substance can dissolve eh?
L: Yes.
T: That is it. So, there are a lot that we can do. I think we are done.

Classroom observation: Lesson 3. Video 3
Yebo Secondary School 03/07/2014
T: Ok, the winning group will come out here after this lesson.
LLL: [Learners making noise while working in their groups]
T: Ah, let us start looking at other things. What?
LL: They are fighting for a book.
T: Don't worry, don't worry!
L: They are blocking my views.
T: Your views where? On the chalkboard?
L: No, from the camera.
T: Ok, stop blocking his view is it clear.
LLL: Yes.
T: Ok.
L: Sir just take that camera and put it there.
T: So, you should concentrate for you to know what make these two things different. Can we look at the diagram; there is something which makes them to be different. I don't know if you

will be able to see that. Now this set-up here we are looking at fractional distillation. At first we look at what? At the first one we looked at what?
L: Simple distillation.
T: But this one is what? Fractional Distillation. And now let us look at the process involved in the fractional distillation. That is lesson three. This is the method that normally uses to separate two liquids. Two miscible liquids. Let's look at the word miscible what does it means. Miscible liquid? Two miscible liquid what does it mean?
L: Distillation.
T: Distillation is the process that is normally used to separate two or more miscible liquid or substances. When something is miscible what does it mean? Miscible? I gave you those words. You are not reading. In the first lesson I gave you the definitions of these words. Miscible what does it mean?
L: [murmuring; missing someone]
T: Not missing someone. Miscible liquid? Siyave. Can you tell me miscible what does it mean?
L: Substance that can be mixed
T: Substance that can be mixed neh. Two liquids that can be mixed. Now if two liquids are mixed together how can you separate them? If two liquids are miscible they must be separated by fractional distillation isn't it?
L: Yes.
T: So, Miscible means they can mix together completely. Ok. The following happens during the process of fractional...?
LLL: Distillation.
T: Fractional Distillation. So, the first one we say; the mixture is heated, you can see it on the chalkboard eh.
L: Yes.
T: Ok. The mixture is heated. Then at about 78^0C the ethanol will begins to what?
LL: To boil.
T: To boil neh?
LLL: Yes.
T: We are looking at example before we will be coming to this one. We have got two liquids there, ethanol and water neh?
LLL: Yes.
T: How can you separate the two liquids which can be mixed? How to separate them? We are looking at ethanol and water. And ethanol in simple English which everybody knows is alcohol.
LLL: Yes.
T: Yes. Its alcohol. Eh, now for example when alcohol is mixed with water how do we separate them? That is what we are looking at now. We are saying, when the mixture is heated at about 78^0C alcohol begins to boil. What do you think happens when alcohol starts boiling? When ethanol starts boiling what do you think? Repeated. Because we are saying when it reaches the temperature of about 78 ^{0}C alcohol starts to boil.
LLL: Yes.
T: What do you think will be next? [teacher asked and paused before mentioning after boiling] After boiling?
L: The ethanol will evaporate.
T: Ethanol eh. Because ethanol is the one which starts boiling which means it start evaporating. So, some water evaporates too. Is that clear. And then some mixture of ethanol and water vapour rises up the column eh.
L: Yes.

T: So, we will come to the poster later on neh.
LLL: Yes.
T: Then from there the vapour condenses on the glass what? Bead. When water vapour condenses what happens to it? It changes from which form to which form? Repeated.
L: From sound.
T: Sound? No. Simaho?
L: It changes from gas to liquid.
T: It just changes from gas t liquid. Eh. Alright. Eh, let's proceed. When the vapour condenses on the column making the beads to be hot. Then when the beads reach about 70 ^{0}C, the ethanol vapour no longer condenses on them. Only the water vapour that is condenses and the water drips into the condenser. I think you know what is a condenser so far neh. It will be forced into a condenser. The ethanol vapour will be forced into the condenser. What do you think will happen when this ethanol will reach the condenser what will happen? What do you think? Repeated. When this vapour of ethanol reaches the condenser what do you think? What do you think will happen? Eh. People let's talk. The ethanol will be forced into the condenser. What do you think will happen to the ethanol? Repeated. Kantana?
L: It will change.
T: It will change eh.
L: Yes.
T: To stone?
L: To liquid.
T: To liquid. Very good. Means it will change from a vapour of a gas into a liquid. Ethanol will condenses liquid ethanol will drop into a beaker [Teacher pointing at a beaker on the diagram drawn on the poster]. A sequence that why you see this circulation here. It just trying to repeat what happened here [pointing on drawn diagram on poster]. What is happening here is this is a mixture of ethanol and water eh. Now when you heat this solution here. You know what is a solution neh?
L: Yes.
T: What is a solution? Eh. The answer is on the chalkboard. What is a solution? I said this is a solution of ethanol and water neh.
LLL: Yes.
T: What is a solution? Because we cannot use a word here that we don't what it means. We must first know what it is. On the diagram here we are busy heating and this is the solution of ethanol and water. What is a solution?
L: Is a mixture of a solvent and solute.
T: That is it is a mixture of two things. A mixture of solvent and solute that is a solution. Then, eh1 now we are saying if we heat this solution here [pointing at a diagram on poster] ethanol will start what?
LL: Boiling.
T: When it starts boiling? It does what?
L: It evaporates.
T: It evaporates eh?
L: Yes.
T: And when it evaporates this are the glass what? [pointing on poster]
L: Glass beads.
T: Eh, the glass beads. The glass beads. What are the beads anywhere? Just the beads. We that one is a glass, eh?
L: Yes.
T: But the problem is the beads. What is the beads anywhere? [teacher permitted a learner to code switch and mention the beads].

L: Yiranda.
T: You heard?
LL: No, some Yes.
T: It is here, here. [teacher showing learners his necklace made of beads]. These are the beads. These is what they put in here but that is made from glass. Is that clear?
LLL: Yes sir.
T: They are made from glass that is why they are called glass beads. The ones that we use to put in. They are fully packed here. What use to happen ethanol evaporated up to here, and this place is cold the alcohol starts to whatever. condensing on this one, then from there these beads starts getting what?
L: Hot.
T: Hot. When these beads will reach about seventy degree Celsius this ethanol condensed on beads start doing what?
LLL: Evaporating.
T: When it starts evaporating here it will be force to pass by here. It will not go up here because it is blocked here. Is that clear.
LLL: Yes.
T: [Teacher show learners on the diagram while explaining]. There is no way they can be passed here. Therefore, they can be blocked and pass here. When they reach there [pointing on drawn diagram]. It is very cold here, then it will change from a vapour into a?
LL: Liquid.
T: Into a liquid. Then from there it will start dripping down here and we get ethanol here [showing learners where ethanol will be collected on diagram drawn on the poster]. What do you think will be left behind here? Repeated. English. Christine Maseka Sondaha? What do you think what will happen here?
L: [Christine failed to answer] while other learners where eager to respond.
T: The same thing like if I will send all the boys out, what will be left behind?
L: Girls
T: Only. Girls. So, we are saying we are separating two things here. Ethanol and what?
LLL: And water.
T: Now ethanol is evaporating first then it will be forced here and then it drips out here. The question is what will be left behind?
LLL: [Most of the learners rise up their hands to answer].
T: Paulus.
L: Glass beads will be left behind.
T: Glass beads will be left behind here neh.
L: Yes.
T: Thank you very much. It is wrong. Someone else. Sara?
L: Ethanol and water.
T: Ethanol and water.
L: Yes
T: Maybe correct maybe wrong. Likuwa.
L: Water.
T: You see. Ethanol and water. These two things were mixed together. Now why are we doing this is we are trying to separate them. Now when you start heating ethanol at about seventy degrees Celsius will start evaporating out. It moves up in form of vapour then from there when it reaches here it condenses on glass beads. Now when it reaches the glass beads these things also will start feeling hot. Just taking the simple example. You know when water is boiling in a pot neh?
LLL: Yes.

T: You use to see the steam moving up neh?
LL: Yes.
T: What if you put your hand there?
L: You will feel hot.
T: That is the things which happen here also when liquid moves up in a form of a steam that we call vapour this things can be become hot also are we clear?
L: Yes sir.
T: Then from there, the temperature of this thing also rises. When it reaches 78 ^{0}C it again continues evaporating eh. Now from there it will be forced to pass here [teacher showing the learners on the diagram were gas will be forced to pass] into the condenser. now into the condenser it will change into a liquid and starts to dripping out. **Who** will drip out?
L: Ethanol.
T: Its ethanol neh. **Who** will be left behind?
LLL: Water.
T: Water. That's how we use to do it.
L: Ok.
T: Yes. Water will be left out, because alcohol is what will drip away eh. Heke?
L: Sir.
T: Yes.
L: What about water there can it evaporate also?
T: It will not evaporate in the sense that the boiling point of ethanol is 78 ^{0}C and the boiling point of water is 100 ^{0}C eh.
LLL: Yes sir.
T: Let's use a simple. Let's just ignore these things. Let's use common things that we know. Let's use the speed of a car. A car travelling at 78 km/h and 100 km/h. Which one is driving slow? This one neh [pointing at 78 km/h on the chalkboard].
LLL: Yes.
T: And which one is driving faster? This one neh [pointing at 100 km/h on the chalkboard].
LLL: Yes.
T: Which means this one [pointing at 78 km/h] which is very slow is the one that will boil out very fast. Because for example let look at the kilometres. There are two distances; you are all here [Teacher drawing on the chalkboard] Heke and Siyave. You are all at this place eh.
LL: Yes sir.
T: Now, we are all coming to this place [pointing at a point on chalkboard] and there is one place here [pointing at a point drawn on chalkboard]. Now, Heke is going to travel from A, from where you are. And now, Siyave is starting here B. Who do you think is going to reach faster? Someone at the distance of 78 km/h and 100 km/h who will reach faster?
LL: 78 km/h.
T: Its 78 km/h.
LL: Yes.
T: That's why when its boiling temperature starts rising neh.
LLL: Yes.
T: Now, what number we will look at first 78 neh?
LLL: Yes.
T: Now with this temperature this ethanol starts evaporating. That is their maximum that they can go is that clear? Now, for water to start evaporating again it must reach what?
L: 100 ^{0}C.
T: 100. But by the time it will reach 100 all the ethanol they are finished. Is that clear. Who will be left is just the ethanol. I mean the water will be left. [Teacher withdrawn the statement ethanol will be left]. What make them different are the boiling points. At this temperature all

the ethanol will start evaporating but water that time it will not evaporate just a bit. What it means but will not go. Who will go is just ethanol only. Then from there the water will remain behind. Until, when you continue heating. If you continue heating the temperature will increase if it reaches this temperature [pointing at 100 ^{0}C] the water also start evaporating. But if it will not reach this temperature the water will not evaporate. So, it remains in the form of liquid water. Until when it reaches 100 ^{0}C is when it start evaporating the boiling point of water. Then we say this method can also be used to separate different gases from air and also crude oil. And the oil that we use in different cars. Eh?
LL: Yes.
T: You know the petrol we are putting in the cars or tractors, eh?
L: Yes.
T: In the caterpillars also what fuel are they using?
L: Diesel.
T: And those small cars are using?
LL: Petrol.
T: Petrol neh. But these things they use to get it at one place and be obtained using process of distillation process. But they have to get the different types of boiling points then from there they have to start boiling. Then from there they start evaporating according to their boiling points. That's how they are separating them. So, you can start doing your own business here. I think that is where we are ending for today.
L: Sir?
T: Yes.
L: All the oil they use to find them at the same whatever?
T: No, they use to find them like they are all mixed together. At the place they use to get them they are completely mixed together. They are not found diesel alone and petrol alone, no they are found mixed together.
L: Nan!
T: Yes. Listen here. A good example, that's how we use to get them. Just use to be at one place all of them just mixed together. Then from there they will collect the whole mixture, petrol is there, diesel is there, paraffin is there and this butane used in aeroplanes is also there. then they put everything in a container and starts heating them. When they started heating them, all this substances they have different boiling points. Which means each one will boil at its own temperature then will move out. just like that, when you reach your temperature just get off. Just like you are travelling from Rundu to Matumbo in a bus neh?
LLL: Yes.
T: When you reach your place will you proceed?
LLL: No.
T: You will get out.
LLL: Yes.
T: That is the thing. When you reach your place you get out. it means you move out. so, the rest who are proceeding will move on. And those living at Shinguruve will also move out when they will reach there. That is how it uses to happen. So, it's very simple.
LLL: Yes sir.
T: For reference for further reading. If you read those books I give you, you will see it's there.
LL: Yes. Sir?
T: Yes.
L: What if I will mix water and sugar. When I boil it which will boil out first.
T: When you mix water and sugar and boil it. What will boil out first?
L: Yes.
T: Water will boil out first. Proceed, proceed yes.

L: What will happen to the sugar?
T: It will remain there. It will remain there.
LLL: Awe. [Code switched]
T: I am telling you! Listen here, you see, try to boil something eh. Just try to dilute sugar into a liquid eh. Try to boil it until water starts evaporating eh.
L: Yes.
T: And then after some minutes just try to look at that solution. It will look a bit ngwe rumbororo kanunu ngwe yalikwata-kwata kanunu, kuyimona ngoso [**Teacher code switched for learners to understand better]**.
LLL: Yes.
T: Which means a lot of sugar is just left there. not completely sugar, but there will be some sort of water inside again. But the more you keep heating all the water will evaporate out and what will remain there is the sugar. Then from there burning will start to take place. Because sugar is a solid and start burning.
LL: Yes sir.
T: That is what is happening in your pot. When all the water has been evaporated your thing left there will start burning. That is the thing it will start burning. Just try to put a lot of sugar into water and start heating. You will see the water will evaporate. And if you continue heating, you will see it will start burning. That is sugar now. Some more question, some more questions?
L: No question sir.
T: No questions eh?
LLL: Yes.
T: So, alright. Here are the activities that will separate the groups now. [Teacher distributing activity papers to learners]. That is yours and one here. Get closer and... . So, if you did not listen is up to you. Alright I want my papers when you are done.
LLL: Yes sir. [Learners busy working in groups but discussions was mostly in mother tongue and teacher did not intervene].
T: So, the best group. Ok. Finish, finish, finish. Eh, there are those groups who are still missing here. I only got one. There should be six groups. Sit down, sit down, and sit down. Is that answering [After looking at learners work]? Like number three is the easiest one. Very simple. Make sure that spelling must be correct. Wrong spelling the answer is wrong, that is how we are doing it in science. Good day.

vii. Learners Brainstorming session on Kashipembe

IQ.1=	Interview question
IQ.2=	Interview question
L1=	Learner one
L2=	Learner two
L3=	Learner three
L4=	Learners four and etc.

The questions are as follow:

IQ.1: What types of fruits are being used in the community to make Kashipembe? You may just mention it in the vernacular (Rumanyo) then we will translate it in English together as a class.

L1: Mangetti fruits (Ngongo)
L2: Orange from the forest (Maguni)
L3: Berries (Mpundu no Makopa)

IQ.2: Explain how Kashipembe is made? Give the step by step procedures. Here you are required to list the step by step procedures on how Kashipembe is made.

L1: When you are using the mangetti fruits (*ngongo*).

First you take the mangetti fruits, and put in the metal drum, pour in water, put on fire and let it boil. When it turned colour you take it out and pound it. And mix it. But you should leave out some to serve as yeast. After that you leave it to last for two days. When it is fermented you can then start distilling (process of distillation) to get Kashipembe. But readiness depends on the person who prepared the content mixtures, some takes only two days other takes longer (we call it *ruwoko*).

L2: How to make *Kashipembe* with mangetti fruits.

First of all you boil it, after boiling put it on the ground and starts pounding to remove out the flesh *(ghutumpi*) and the skin/covers (*vipapa*). From there they mix the cover/skin and flesh with water and put in the plastic/metal drum (*ndoroma).* While the hard nut-like seed (*vigongotji*) is put aside. And leave it to ferment. After fermentation, distillation process will then start using another metal drum for boiling (*ndoroma yokuterekera*) again, and then *Kashipembe* is received from condenser (*muyengo*).

L3: How to make *Kashipembe* with mangetti fruits.

Firstly, you have to go in the forest and collect mangetti fruits with a sledge pulled by oxen (*shireyi).* You take all the mangetti you want to use and put in a big container, pour in water and put on fire to let it boil. You boil it just like you are cooking something. After boiling it, you pound it using a pistle and mortor to remove out the cover /skin (*vipapa*) together with the contents (*ghutumpi*). Then, you put it in the big container to mix it with water. Put mix contents in a big container and cover it so that you can leave it for two days. When it is ready (fermented) then you can start with distillation process. You put the fermented contents in a cooking drum (*Kanyungu kokuterekera*) and put on fire wood, the put on fire. You keep on stirring it several times. When it starts to boil, cover it with small zinc sheet (*shipereki*) and put on mud on top of it. Mud will stop smoke from coming out through the opening. The steam will go into a condenser (*Muyengo*). Then, put water in condenser to cool it. Eventually, water drops out of the condenser and collected as distillate (*Kashipembe).*

IQ.3: What apparatus/materials are used to make *Kashipembe*? With this question you may just mention the materials it in the vernacular (Rumanyo) then we will translate it in English together as a class.

L1: Round bottom flask (boiling metal drums, *ndoroma yokuterekera*)
L2: Glass rod **(**stirring stick, *rupandi)*
L3: Condenser (metal pipe inserted into a wooden trough, (*muyengo*)
L4: Bunsen burner or heat source **(**Firewood, *vikuni*)
L5: Tripod **(**Metal or stone supports, *makankara*)

L6: Matches (*kaparu*)
L7: Water (*mema*)
L8: Stoppers (zinc sheet, *sipereki*)
L9: Stoppers (mud /clay soil, *shighuru ndi lirova*)
L10: Conical flask (cut cans or1 litre bottles (*makende*) or a cup)
L11: Heat source (grasses, *mushoni*)

IQ.4: Who normally makes *Kashipembe* man or woman?

L1: Woman, normally old woman makes *Kashipembe.*

IQ.5: How many days can it take to make *Kashipembe*? And give a reason to support your answer.

L1: Two days, for it to get ready (fermented).
L2: It takes almost more than two days, as it involves the collection of mangetti from forest and all the work of preparation.
L3: It takes a week, because one day for collecting mangetti, second day for cooking and pounding together with mixing. You add sugar the next day. Then, you leave it for three days to ferment before you start distillation process.
IQ.6: Why will you add on sugar?
L4: To make *Kashipembe* much more alcoholic concentrated.
L5: The one without addition of sugar ferments faster than the one with sugar added to it.

IQ.7: Who is allowed to drink this *Kashipembe*?

L1: Old people
L2: People above the age of 16 years
L3: Old people especially between thirty and forty years, reason being that they are used to drinking alcohol.

IQ.8: What some of the scientific concepts or terms associated with *Kashipembe?*

L1: Fermentation
L2: Distillation
L3: Evaporation
L4: Distillate
L5: Boiling
L6: Condensation
L7: Filtration
L8: Miscible
L9: Heating
L10: Purifying
L11: Sorting
L12: Mixing
L13: Diluting
L14: Tasting

IQ.9: Do you think the making of *Kashipembe* is a good practice or not in the community? And support your answer.

L1: Not a good practices, because it can make people drunk and kill people.
L2: It is a good practice, because when you are making more *Kashipembe* you are making money.
L3: Not a good practice, because people who use it sometimes use to beat other due to its access.
L4: It is a good practice, because it makes old people to be drunken even young people when drinking it.
L5: It is a good practice, because it makes all the man and boys to come together when they are drinking *Kashipembe.* It makes people to discuss their stories and share ideas when they are drinking it. But it is not good practice because it makes someone to be a killer by drinking it when you are drunk.
L6: Not a good practice, because it can cause throat cancer. Good example is that man who died last year because of throat cancer due to *Kashipembe*.
L7: Good practice, because it is improving the living standard of people who are selling it. On the other hand it is a bad practice, because bring bad habit to the community and the families.

viii. Community member's interview

IQ.1- Interview question one

IQ.2-Interview question two

FQ- Follow-up question

RT-Researcher's translation

CMR-community member's responses

IQ.1: Nyango munke mwaruwanitanga murenke Kashipembe?

RT: What types of fruits do you use to make Kashipembe?

*CMR: Kwaruwanitanga ngongo, nkekete, mpundu ntani no makopa. RT: We normally use mangetti fruits, nkekete, mpundu, makopa (*these are types of berries*).*
FQ: Podino nyango munatwenyaura, nyango munke mwaruwanitangapo unene?

RT: Amongst the mentioned fruits, which one do you use most often?

CMR: Atwe unenepo ngongo ndo twaruwanitanga.

RT: Mostly we use mangetti fruits.

IQ.2: Lipuro lyokukwamako, walye tutante tupu maghuyivi ghenu weni mwaruwananga Kashipembe? Yira weni omo avarekanga kadidi-kadidi tupu vene mukuwapayikira dogoro kukakendja.

RT: Next question, may you please tell me your experiences or what you know on how do you make *Kashipembe* step-by-step from the beginning of preparation until to the distillation process?

CMR: Omotwarenkanga:

- *kughupa ngongo kutura mulitoromani (metal drum);*
- *makura oteremo mema ntani kuhamekako mundiro divire;*
- *apa dikutjindja ruvara makura kughupako mundiro ntani kudighupamo ghuditure palivhu;*
- *makura kughupa sinu (pistle) no muntje (mortar) otameke kudishopora;*
- *Pakumana kudishopora makura ododuhwire pa sipereki (zinc sheet) utameke kutoghorako dinya ngongo twatwenyangashi vigongotji (hard nut like seeds);*
- *Makura apa mumana kutoghorako vigongotji omuvikutulire. makura kughupa vigongotji kuvitura mundoroma kuvi kwayura mumema ntani kuvighupamo mukaviyaneke;*
- *Makura kughupa utura (mixture of outer skin and flesh) kughutura momo mumema ghovigongotji mundoroma yokurungira (drum for mixing) makura kuvikosha (mixing);*
- *Makura kughupa suka (sugar) kuturako. Makura nkene munamana kutera suka kufikako nonguwo (blanket) ndi sipereki (zinc sheet);*
- *Kuvisuva virare mayuva maviri ndi matau nkene vinapi (fermented) ntani ngoli ngomu kavitura mundoroma yokukendjera (cooking drum)*
- *Makura kuvareka ngoli kukendja.*

RT: How do we do it:

- you take mangetti fruits (*ngongo*) and put in the metal cooking drum;
- then you add in water and put on fire to let it boil;

- when it turn reddish brown colour, stop boiling;
- then take it out and put it on the ground;
- then you take a pistle (*muntje*) and mortar (*sinu*) to start pounding;
- After pounding you put it on the zinc sheet *(sipereki*) and start picking out hard nut-like seeds;
- then you put these seeds (*yigongotji*) aside separately;
- Then mixtures of outer skin and flesh *(ghutumpi*) is poured into the metal drum *(ndoroma*);
- Then you put the water in the drum with hard nut-like seeds and pound it with a pistle (*muntje*);
- And then you take the water used with the hard nut-like seeds and put in drum with mixture (*utura*) and stir it together;
- Take sugar and add on the stirred contents of mixture and stir it again then cover it with old blankets or zinc sheet;
- Leave it about two to three days for it to get ready (fermented) and once it is fermented it is called v*itapwira;*
- Then you can put it in the boiling metal drum and put on fire to start with distillation process.

IQ.3: Ya kughupako vinya. Lipuro lyoghutatu. Vighamba munke mwayuvha ko vyokuhamena Kashipembe? Turenke tupusi shihoninito yira kumukuro. Asi nkene ghuna karapanyama kwato kuyenda kumukuro nevisi ngakakukwata mvhuu. Kukasipembe ngoli kwato vyo mwayivako vyokufana ngoli.

RT: Ok. Apart from that, the third question. What kind of story is there in connection of *Kashipembe*? Taking an example of the river. They said if you had sexual intercourse you should not go to the river as you might be attacked by Hippopotamus. Do you know anything like that with *Kashipembe*?

CMR: Navyo mpovili vyokurenkasi nkene murume nomukadi anakasondera ayepo kuhura virukure. Asi malyata mpadi makura avirukura. Hambara ndimbyo vya kararopo tupu mbyovyo.

RT: Yes, we have the belief that if a woman or a man had sexual intercourse and come where they are making *Kashipembe* the contents or mixture will come out from the condenser instead of *Kashipembe* itself. Because it is a kind of a taboo then it will not be successfully. That is what we have as a belief.

FQ: Ya, kanimonanga pakare nkene munali makura muyepo kumurenka asi likusenu unene kumawoko, ovinyane vinke kavaviruwanenanga?

RT : Ok, I use to see in the past if you have just finished eating and come there they will tell you to wash your hands thoroughly, why was it like that?

CMR : Yi, morwamungwa. Nkene muntu anakwatakwata vininke vyomungwa ayakwateko makura vyakona kudjonauka vene. Makura pakukavi kendja mema-mema. Mungwa nokasipembe kapi vyali sana, mpili apite mara kukara mema-mema kwato nka ururu.

RT : Yes, because of salt. If a person touches salty substances and touch the contents or mixtures of *Kashipembe* it will be spoiled. When you do it, it will be tasteless. Salt and Kashipembe are not in good terms, even if *Kashipembe* comes out but still there will be no alcoholic concentration in it.

IQ.4: Walye viruwanita munke mwa hepa mposi muruwane Kashipembe?

RT : What materials do you need in order for you to make Kashipembe?

CMR : Evi twaruwanitanga Kashipembe. Ndoroma yokuterekera, ligarona lyokukoshera (ndi ndoroma vatenga) ntani muyengo ndi mbyo twaruwanitanga unene pakukendja Kashipembe.

RT : What we use to make *Kashipembe*. Cooking metal drum, big container for mixing (even metal drum which is cut open at the top of it) (*ndoroma*) and a condenser (*muyengo*) these is what we use most when making *Kashipembe*.

IQ.5: Walye oghu Kashipembe varenani ava vafero kumuruwana vakamali ndi varume? Tutureko nokonda tupu.

RT : Who supposed to make Kashipembe, males or females? Give reasons.

CMR : Ya, yiramu mwetu unene ndi mbovo vakadi vene mbovaviruwanango. Konda ndjeyisi atwe vakamali twe tupu twakaro noudito muliparu mbyo twarenkeranga tupu kehe ruvede tu kendje Kashipembe tukuvatiliteko mulipata.

RT: Ok, like here mostly ladies are the ones making *Kashipembe*. Because we ladies are the ones who have difficulties in live, that is why we always make *Kashipembe* so that we can use it to support our families.

IQ.6: Walye mayuvamangapi aghupanga Kashipembe ntani vakamukenga. Kuvarekera tupu pakumanakumurunga vitwaretupu kumeho dogoro kukakendja?

RT : How many days do Kashipembe take before it is ready to be made? Just starting from the mixing of contents until the day of distillation process.

CMR : Ruvede rokurenkasi namuntji ghuna virungu dogo ngokakendje, ngogho mayuva maviri vene. Kuvhura tuvirunge namuntji weno Mandaha, yona Uvili viyusare muUtatu ndi kukendja. Kuvhura ghararemo mayuva maviri ndi matatu kare anapu nka kumughura. Kasipembe ndando zongwa sili, azokugenda nawa ntani kuvhena mosili.

RT : The period from today when it is prepared until you carry out distillation process. It takes only two days. We can mix it today Monday, and tomorrow Tuesday allow it to stay there to ferment, then Wednesday we can start distilling. It might only take two to three days to be finished buying it. *Kasipembe* is a good business and again it is profitable.

FQ :Vinke uvhurakuruwanako mposi vikwangure kuvira ?

RT : What can you do so that it can ferment fast ?

CMR : Aye, kwato. Mara omu twaruwananga kusuvidamo vitapwira vimwe muligarona ndi mundoroma. Makura ovyo vitapwira mbyo uwedererako makura kukwangura kuvira. Nkene patini unaviturako apa yika toona vili yaghu ntambiri kungurova vinatameke kare kuvira. Ovyo vitapwira mbyo ngoli hingo yako.

RT: No, there nothing you can do. But, what we use to do is to leave out some of the contents *(vitapwira)* in the mixing container or drum. Then, the left over *(vitapwira)* is what you will add on then it ferments faster. The left over *(vitapwira*) act as the yeast.

IQ.7: Nkene muna mana kukendja Kashipembe, vare vafero ngoli kumunwa?

RT: If you are done making Kashipembe who supposed to drink it?

CMR: Ndi vene-vene vanya vokurenkasi pakatji tupu kapisi musamane ndi mwanuke aye pakatji tupu vanya vokurenkasi rutu simpe ruwawa. Vasamane kapi vana kunwa nka nawa-nawa Kashipembe morwa marutu ghana roroka. Morwa Kasipembe nkondo unene nokuvhurasi kumunwa vanuke. Viruwo vimwe vanya vanwango Kashipembe kuwawa kene kapi kali yona, makura evinavyo kurenkita vanuke vakare nowoma asi nevisi vakawawa navo morwa Kashipembe.

RT : People who are supposed to drink Kashipembe are those who are not too young or too old but just in the middle age. Just for those people who are healthy and physical fit is better.

Old man and woman are not drinking Kashipembe nowadays because they are ageing now. Only young man and woman who are drinking Kashipembe. This happens because Kashipembe is regarded as one of the strongest alcohol. When some people drinks it on an empty stomach it causes dizziness and tiredness and even falling. When young ones see all these effects they tend to be afraid and make them not to drink *Kashipembe*.

IQ.8: Omo mwavimonangako ngoli nwe, vidonandi viwa kukendja Kashipembe umughulite mumukunda?

RT: How do you look at the making of Kashipembe, is it good to make and sell it in the community?

CMR: Mwene-mwene kapisi mudona kaya muwa. Omo twamurenkanga pamwe novaruyenda ndjira kumunwa. Kapitwarenkanga asi ndi vamunwe mbava vomumukunda tupu. Kapi ayitanga maudito vene muwawa tupu. Udona tupu ngogowosi nkene mumntu kumunwa kukorwa. Morwa nkene muntu anakorwa awe ruvede rokufu kuvhura kufera mundjira. Ano uwa ne ngowo vene wokuwanenamo viyeramo.

RT: actually, *Kashipembe* is not that bad. Because we make it so that even visitors should drink it not necessarily the villagers only. Kashipembe does not bring problems it is just ok. The only bad part is that when a person is drunk and fall on the road night time during winter, the person might die there. This is one of the problems *Kashipembe* brings. But the good part of it is that you are earning profit from *Kashipembe*.

IQ.9: Vinke vatuliranga ko suka kuvirungarunga vyaKashipembe?

RT: Why do people add sugar to the mixtures or contents of making Kashipembe?

CMR: Morwa kurenkera edi mwaka twakuyayenda weno ngongo kapidakuwana nawa mema makura kwato utovara. Makura mbyo twarenkanga tutureko suka mposi avhuke Kashipembe. Ntani kurenkerasi Kasipembe akare nonkondo. Nkene kuruwanita ntjako yongongo yo 25 kg ntani neyiyo suka yo 25kg, kuyura ndini ya litera 25 (25l) yoKashipembe. Ano nkene kwato suka kuwanako yimwe tupu yalitera ntano 5. Nkene otwikire asi ghughupeko litera rombiri nantano, ururu kupwamo woKasipembe makura kukwamako Matjatja.

RT: Sugar, because like nowadays mangetti fruits (*ngongo*) is not getting enough water and it is losing its taste. That is why we use sugar to obtain more Kashipembe. And also, to make it tasty for *Kashipembe* to be strong in alcoholic concentration. Example if you use 25 kg of mangeti fruits and you add on 25kg of brown sugar, you will obtain 25 litre full of *Kashipembe*. But if you did not use sugar on 25 kg of mangetti fruits, you will only get 5 litres of *Kashipembe*. And if you continue to obtain some more, less concentrated *Kashipembe* will come out, we call it *Matjatja* and your *Kashipembe* will not be alcoholic enough.

ix. Semi-structured interview with the learners to make meaning about their community visit and follow-up *Kashipembe*.

IQ.1= Interview question

IQ.2= Interview question

L1= Learner one

L2= Learner two

L3= Learner three

L4= Learners four and etc.

IQ.1: Do you think science teachers should consider learners prior everyday knowledge when they are teaching distillation?

L1: Yes prior knowledge is important. For instance like the presented topic of yesterday. The teachers have to ask question to find out if the learners knows something about the topic before introducing the new topic. And if the teacher is continuing with the previous topic he or she should revise the covered topic to see if learners understood the topic or not. To find out if they have really acquired skills and kept it in mind about the topic.

L2: It is very important for the teachers to consider the prior knowledge of the learners in a class. Because, when we talk of Physical Science is like a combined of knowledge from school and the communities which need to be used and come up with solid solution. And this will make the learners to understand the topic like distillation.

L3: It is very importance because it will make the teacher aware of the people he is working with and what he is going to talk about. Just like distillation if they know what use to happen at home they will bring that at school and make a teacher to relate it to the main topic. Taking examples of experiments on distillation, if there is a person who did it already it is easier to make other understand it also. This helps the teacher to know where to start.

L4: It makes the work of the teacher easier. As the one who knows something about the topic will be able to lead the topic and make the lesson to flow. Because the learner might do about the topic at home or previous grade then it is easy for other to follow. This will automatically save time of the teacher by not explaining more and more repeating the same topic.

IQ.2: Do you think it is importance to involve a community member in the learning of science (distillation) at school? Like the way we are doing it now with the woman who is preparing Kashipembe.

L1: It is very importance because the community member might know something which we do not know. So, by involving that person he or she will teach us those things which we do not only then we learn it from him/her. And will show us that this you do it like this and that you do it like that its better.

L2: Yes they are needed. For instance in school we use beakers but in the community they can use other container to substitute a beaker. As this community member is showing us all this, we are exploring and knowing a lot about the materials used to carry out distillation in the absence of scientific materials.

L3: It is very important. Because a teacher will teach and learners will not understand what the teacher is teaching. But when that community member will explains it in our vernaculars' we learners will understand it better. Really it very important to involve the community members in the teaching of science topic like distillation.

L4: It is very important because some learners do not understand English used. So, when they will explore in their vernaculars they easily know that this is called a beaker , a horse pipe or others. Because even if you know things in English and you do not know them in your language it is a problem and you might not progress.

IQ.3: Looking at the topic presented, do you think it helped all the learners or just the few of the learners?

L1: To me it just help some few individuals. Because, some of the learners who did it or knows the things already it helped them and understood the topic. While for other learners did not understand it as it was only for drawing did not see reality.

L2: The topic help and it is important to learners. Some might not see its importance but they might need it in the future. Especially, when the time of parties you might be told to make Kashipembe or vinegar. Then you will recall with what you have been taught at school then it might be helpful. I can say whatever they teach in the class is all useful.

L3: In addition to that, it was important to everybody in the class. Because even myself I did not know how distillation process works, but after that presentation I could catch up with the topic. And now I know that these things are done in this way.

L4: Yes, it was helpful. The drawing sometimes is helpful because the more you are drawing the more you know it and you will be able to connect it yourself if they are given to you. If you do not know how to draw it will not help you, you will just see the picture there but you do not know how to connect it. This might lead to you to wrongly connect the apparatus in their right position on the figure.

IQ.4: How do you look at practical work in Physical Science on the topic distillation?

L1: Practical's are helpful in school. As things which you do by touching is easier to remember it. Yes, you can study by figure on papers but still practical's are just the best as you will be hands-on doing the work. Practical's helps learners to remember the work even when asked in examination. Practical is very important.

L2: Practical's are very important in science because when a learner will work with those equipments he will not forget. Because when the learner is going to write exam he or she will remember how it was used and will be able to give correct answers. For example the use of the thermometer, the learner will remember it easily because the thermometer was used during the experiment.

L3: Practical helps us to understand things more, the more you do it is the more you understand it and that is the more they are becoming easier. Because if you just see it, it is not enough. Like thermometer you just see it and know its function but you do not know how you can read it and take the temperature. If you do not know how to use it you might fail it in examination.

L4: In general practical's. Let's say you used the equipments at school during practical, when you reach at home somebody might ask you the uses of a certain apparatus. Then, it is easy to tell the person all the uses you gained from the practical. In other words we need action not just talk there and leave.

IQ.5: How do you feel to be a participant of this study?

L1: I feel very happy because the study is helping me. Even maybe in future I will do the same work I know what the basic procedures to be follow. I will be able to follow it as it was given to us and I have learned how to approach learners to negotiate just like how you did it to us.

L2: I am also happy to be a participant in this study. It helped me to know how this process is being carried out and to relate it to school science. Being a member also gave me ideas on how I can assist other learners to partake in research like this one. Because in class we only talk about investigation and we do not go out and experience it in the society instead they just write it down. During this research for us we went in the community and discuss with the community member and find out. And now even when you present it to your teacher he will also be surprised because some they do not do it correctly they just write and submit. With this I mean some they just sit in their houses and write everything. And now even us we will follow what you did when we will reach there to produce good report.

L3: To me is like this research should continue like that, because it really inspired me and be interested in the topic distillation. I am able to connect it with what we learn in school. There some terms which I did not know but now I know them I am proud to involve in this research as a whole. Now I know much better about distillation then previous years of my studies.

APPENDIX I. Figures of apparatus used to make *Kashipembe*

i. **Boiling metal drum during the process of distillation.**

(Condenser) into cut can and put in the bottle (above).

ii. **Kashipembe received from pipe**

iii. **Hard nut-like seed**

i. **Condenser and a pistle on it**

ii. A woman standing next to prepared and covered contents of mangetti fruit leaning on a pistle.

iii. Mortor

iv. Learners observing the making of Kashipembe.

APPENDIX J Two model lessons

i. URBAN SCHOOL WITH ALL MATERIALS FOR CARRYING OUT DISTILLATION PROCESS

YEBO SECONDARY SCHOOL

SCIENCE MODEL LESSON 1

SUBJECT: *Physical Science* ***DATE****:* *09/07/2014*

TEACHERS NAME*: Mr. Gaps.* ***TIME****:* *40 MINUTES*

GRADE*:* *11* ***PERIOD:*** *1*

TOPIC: *Experimental Techniques*

Learning Objectives:

- *Learners will understand the principles of experimental techniques.*

Specific Objectives:

- *earners should be able to: describe methods of purification by the use of distillation (including use of fractionating column).*

Suggested Practical Activities:

- *Prepare a sample of soluble salt*

LEARNING AND TEACHING SUPPORT MATERIALS:

Conical flask, Liebig condenser, beaker, Bunsen burner, matches, 2 thermometers, fractionating column, salt, water, ethanol, conical flask, round bottom flask, delivery tube, stoppers, resort stand, gauze, glass rod, spatula and wooden block.

PRESENTATION OF THE LESSON

1. MONITORING OF HOMEWORK DONE:

- The teacher should check the homework and mark where possible.
- Give corrective feedback to learner before continuing with the next lesson topic.
- All possible answer should be written on the chalkboard.

2. AN APPROPRIATE SHORT INTRODUCTION:

- Prior everyday knowledge of learners on the making of *Kashipembe* in the community.
- Boiling water from pot during cooking at home.
- Condensation of water on windows of car or house

3. *PRESENTATION OF SUBJECT MATTER AND LEARNING ACTIVITIES:*

SOME LABORATORY SAFETY RULES

- ✓ **Remember not to touch the glassware when it is very hot. Let it cool down before you disassemble it.**

1. Study your lab assignment before you come to the lab. If you have any questions, be sure to ask your teacher for help.
2. Do not perform experiments without your teacher's permission. Never work alone in the laboratory.
3. Safety goggles and a laboratory apron must be worn whenever you are in the lab. Gloves should be worn whenever you use chemicals that cause irritations or can be absorbed through the skin. Long hair must be tied back.
4. Do not wear contact lenses in the lab, even under goggles. Lenses can absorb vapours and are difficult to remove in case of an emergency.
5. Avoid wearing loose, draping clothing and dangling jewellery. Bare feet and sandals are not permitted in the lab.
6. Eating, drinking, and chewing gum are not allowed in the lab.
7. Know where to find and how to use the fire extinguisher, safety shower, fire blanket, and first-aid kit.
8. Report any accident, injury, incorrect procedure, or damaged equipment to your teacher.
9. If chemicals come in contact with your eyes or skin, flush the area immediately with large quantities of water. Immediately inform your teacher of the nature of the spill.

LESSON CONTENTS

BACKGROUND:

Distillation is the process of boiling a liquid and then condensing the vapour produced back into a liquid. It is used to purify liquids and to separate mixtures of liquids. There are many types of distillation, each of which has a distinct purpose. In this model lesson we are going to learn about simple and fractional distillation.

NOTE: Firstly the teacher should explain the meaning of the terms used on the topic of distillation and explain to the learners the functions of the materials used during the simple and fractional distillation processes(see Check List or Glossary).

PART A.

SIMPLE DISTILLATION PROCESS

Activity: Preparing a sample of soluble salt.

Experiment objective:

Separating mixtures and purifying substance. Example: Obtaining pure water from salt water (salt solution) through simple distillation.

PROCEDURES.

What to do:

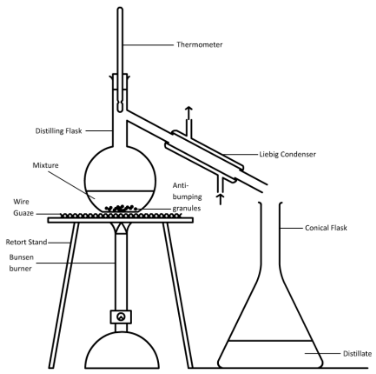
- ❖ Firstly, take a beaker and put in water up to a certain level.
- ❖ Then use a spatula to take salt and put in water in the beaker.
- ❖ Use glass rod to stir salt and water in the beaker until it dissolves completely.
- ❖ Pour the solution of salt and water into the round bottom flask.
- ❖ Set up the apparatus used to carry out simple distillation (arrange resort stand and tripod, gauze and put on the round bottom flask, connect Liebig condenser to round bottom flask using a stopper, put stopper on top of the flask and insert in the thermometer, put conical flask at one end of condenser, connect two delivery tube to water inlet and outlet, lit up the Bunsen burner and put under the resort stand).
- ❖ Take the initial reading of the thermometer.

What happens:

- ✓ Heat the solution in round bottom flask. It boils and steam rises into the condenser.
- ✓ The condenser is cold, so the steam condenses to water in it.
- ✓ The water drips into the conical flask. It is completely pure. Called distilled water.

This method can be used to purify water because the dissolved solids have a much higher boiling point and will not evaporate with the steam, but it is too simple method to separate a mixture of liquids especially if the boiling points of the components are relatively closes e.g. water and ethanol mixture. Then we can introduce fractional distillation for this.

See the diagram below of Simple Distillation apparatus.



https://www.google.com.na/search?q=simple+distillation+set+up+apparatus

PART B.

FRACTIONAL DISTILLATION

Fractional distillation is a method used to separate two liquids which have different boiling points. However, this method only works if both liquids in the mixture are miscible (e.g. alcohol (ethanol) and water) and do not separate out into layers like oil/water.

Activity: Preparing a sample of miscible liquids.

Experiment objective:

Separating mixtures and purifying substances. Example: Obtaining ethanol from mixture of ethanol and water through fractional distillation.

PROCEDURES

What to do:

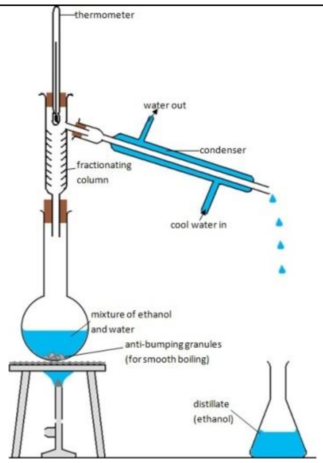
- ❖ Firstly, take a beaker and put in water up to a certain level.
- ❖ Then take ethanol and put in water in the round bottom flask.
- ❖ Shake to mix the contents thoroughly.
- ❖ Set up the apparatus used to carry out fractional distillation (arrange resort stand and tripod and gauze and put on the round bottom flask, connect fractionating column to round bottom flask together with condenser using stoppers, put stopper on top of the flask, insert a thermometer in the stopper on top of the flask, put conical flask at delivery tube from condenser, lit up the Bunsen burner and put under the resort stand).
- ❖ Take the initial reading on the thermometer.

What happens:

- ✓ Heat the mixture. At about 78 ^{0}C ethanol will begins to boil. Some water evaporates. Then mixture of ethanol vapour and water vapour rises up the column.
- ✓ Then the vapour condenses on the glass beads in the column, making the beads hot.
- ✓ When the beads reach about 78 ^{0}C, ethanol vapour no longer condenses on them. Only the water vapour does. The water drips back into the flask from the beads. The ethanol vapour is forced into the condenser.
- ✓ The ethanol vapour condenses in the condenser. The liquid ethanol drips into the conical flask. It is now called the distillate.
- ✓ Take the reading on the thermometer.
- ✓ Eventually the thermometer reading rises above 78 ^{0}C. This indicates that all ethanol has been evaporated, so heating can be stopped.

This method can also be used to separate alcohol from a fermented sugar solution. It is used on a large scale to separate the components of crude oil, because the different hydrocarbons have different boiling and condensation points.

See the diagram below of Fractional Distillation apparatus.



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4. CONSOLIDATION:

The lesson is concluded with review of the distillation methods as described above.

5. ASSESSMENT: HOMEWORK/TASK/EXERCISE

Separation Techniques Worksheet

Name: ____________________Date: _______ Class: ______

True/False Questions

1. Think carefully about the following statements. Are they true or false?

   Circle your answer.

   a. Drinking water can only be obtained from seawater by distillation. True/False

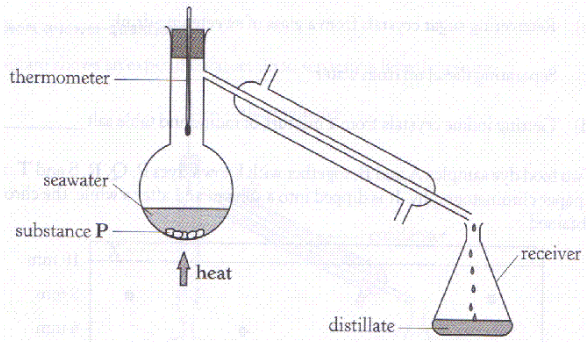
   b. The fractional distillation of miscible liquids is only possible if the liquids have different boiling points. True/False

   c. Mixtures have fixed melting and boiling points. True/False [3]

2. Name the techniques which are suitable for separating the following mixture: [2]

	Situation	Separation Technique
a.	To separate petrol from crude oil	
b.	To obtain pure sugar from a solution	

3. The following diagram shows a set up of simple distillation.



(a) (i) Identify substance **P**.

i. ____

____[1]

(ii) What is the objective of substance **P**?

____

____[2]

(b) Write down distillate collected in the receiver.

____

____[1]

(c) Suggest how you would determine that the distillate collected is a pure substance.

____

____

____[2]

(d) Label the water in and water out on the diagram. [2]

(e) State **one** possible mistake in the set up and explain the significance of the mistake.

____

____[2]

Total Marks: 15

Name:__________________________ Date: ________________ Class: _______________

ACTIVITY QUESTIONS

FRACTIONAL DISTILATION

1. Fractional distillation is used to separate:

i) What type of mixtures?
____[1]

ii) On the basis of what physical property?
____[1]

2. What additional piece of glassware is needed for fractional distillation compared to distillation?
____[1]

3. What is the maximum purity of ethanol that obtained by the fractional distillation of ethanol and water?
____[1]

4. Why can't 100% ethanol be obtained by the fractional distillation of a mixture of ethanol and water?

____[1]

5. Research: How is fractional distillation used in the petroleum industry?

____[1]

Total Marks : 6

6. ***ENGLISH ACROSS THE CURRICULUM:***
   READING ACTIVITIES and WRITING ACTIVITIES:

The learners should be able to read, pronounce and spell out the following scientific concepts correctly.

- ✓ Distillation
- ✓ Simple and fractional distillation

- ✓ Fractionating column
- ✓ Solution
- ✓ Miscible
- ✓ Distillate
- ✓ Conical flask
- ✓ Round bottom flask
- ✓ Liebig condenser
- ✓ Gauze
- ✓ Stopper
- ✓ Tripod
- ✓ Retort stand

CHECK LIST OR GLOSSARY

Definition of terms:

- **Boiling point** is the highest temperature at which substance can change its state from a liquid to a gas. E.g. water boils at 100 ^{0}C and alcohol 78 ^{0}C.
- **Condensation** is when vapour changes to liquid
- **Distillate** is the purified liquid which is collected in receiver during distillation. Eg. ethanol
- **Distillation** is the process of boiling a liquid and then condensing the vapour produced back into a liquid. It is used to purify liquids and to separate mixtures of liquids
- **Evaporation** is when liquid changes to gas
- **Fractional distillation**a process that separates more than one substance at a time, is used when boiling points are different or when mixtures are complex. (eg. ethanol and water). These can be separated since they both have different boiling points.
- **Kashipembe** is a local cultural brew alcohol beverage commonly made in the Kavango Regions.
- **Miscible** when substances can mix with each other. E.g. ethanol and water
- **Mixture is** the composition of different substance liquid and liquid, solid and solid or liquid and solid.
- **Practical activities** these are the tasks which learners and teachers do with hand-on materials to enhance the teaching and learning process.
- **Prior everyday knowledge** is the kind of knowledge which the learner poses about various topics in school sciences.
- **Solution** is a mixture of a solute and solvent. E.g. sugar into water.
- **Simple distillation** the simple separation of a solid and a liquid by evaporating the liquid and collecting it after it passes through a condenser to be changed into a liquid state.

FUNCTIONS OF SOME APPARATUS:

Thermometer is used to measure temperature.

Bunsen burner is a heat source for heating.

Conical flask is used to receive the distillate from condenser.

Liebig condenser is used to condense substance from gas to liquid.

Tripodand Gauze is used to support/holds the round bottom flask.

Round bottom flask is used for burning the mixture or solution.

Matches used to put on fire AND SO ON.

COMPESATORY TEACHING:

If a topic seems not to be understood by some learners, the teacher should organise some extra-classes for those learners to be assisted on specific parts of the topic. ***REFLECTIONS:*** After lesson delivery the teacher should write critical reflections on the lesson, noting how teaching strategies could be changed to meet the lesson objectives. Herea teachershould seat after the lesson and look back to point out what transpired during the lesson presentation.The lesson should then be filed for future adaptation. ***TEACHERS' SIGNATURE: __________*** ***SUPERVISORS SIGNATURE: ____________*** *DATE: __________/__________/ 2014* *DATE: _________/__________/ 2014*