

**The impact of a visit to Lesotho Water and Sewage Authority
(WASA) on learners' knowledge about community health.**

Maretsepile Relebohile Molahloe

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Abstract

There is an increasing adoption of outdoor visits in high schools in Lesotho and this study was done to find out what students learn about community health as they visit Lesotho Water and Sewage Authority (WASA). Eighty Form D (equivalent to grade 11 in South Africa) learners were the participants in this study. In order to capture students' learning a qualitative study was designed. The study used observations, questionnaire (n=80) and semi-structured interviews (n=8) with learners. The data was analyzed inductively and deductively in order to answer questions about knowledge changes as a result of a visit to WASA, and about the aspects of the visit that influence learners' knowledge about community health.

Analysis of the questionnaire and the interviews revealed that learners greatly gained knowledge as a result of the visit to WASA while others developed misconception and others did not change their conceptions at all. The forms of conceptual change identified from learners responses were enrichment and conceptual capture. Learners realized that water purification is not a minute-made activity since there are several steps involved in water purification and that taps are not the main water sources. Learners also became aware that boiling water is not the only effective way of treating water instead other purifying stations like WASA can purify water suitable for domestic use. However, some learners believed that water that has been treated by the sewage plant is not suitable to be purified and used for domestic purpose.

The observation analysis indicated that the physical facilities, displays, prior knowledge and participation during the visit are some of the aspects that influence learners' knowledge about community health. The realism of concepts communicated during the visit enhanced learners' ability to acquire knowledge about community health. The physical facilities such as the machinery at WASA provided the concrete evidence that water is drawn from the rivers therefore rivers are the main water sources. Visual displays contributed much in learners' ability to gain knowledge during the visit to WASA. It has also been found that although manipulation of objects was minimal, learners still gained information communicated during the visit. With the stated findings above, a visit to WASA enhance learner's ability to acquire information about community health.

Declaration

I declare that this research report is my own unaided work. It is being submitted for the degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

(Signature of candidate)

Dedication

To Lebohang and Retsepile for their love and support.

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Chapter one

An introduction to the problem

1.1 Introduction

This study intended to investigate the impact of a visit to the Water and Sewage Authority (WASA) plant on learners' knowledge about community health and the aspects of the visit that influence knowledge about community health. Community health is a topic in the high school level (form D and E, equivalent to grade 11 and 12 in South Africa) curriculum that includes pollution, sewage and water treatment as subtopics. Form D learners were participants in this study because the topic was introduced for the first time, therefore the group suited the intention of the study. WASA is a private company that specialises in water purification and supply within the urban areas of Lesotho. The company is branched amongst ten districts of Lesotho. There are more than thirty schools in Maseru of which some are near WASA and learners may walk on foot to this place. However, other schools outside Maseru take organized field trips to this place. Water pollution and purification are concepts under the previously stated sub-topics and WASA has the complex machinery therefore appears to be the suitable out-of-school setting in exploring these subtopics.

Research studies state that concepts introduced within out-of-school context are held for a longer time (Orion & Hofstein, 1994; Anderson, Piscitelli, Weier, Everett & Tayler, 2002). The reason behind is that science learning within out-of-school context actively involves learners (Lucas, 1999). In Lesotho, I have observed that teachers tend to take learners to places such as WASA and Katse dam in an attempt to provide active learning (personal observation). Lesotho learners might also be benefiting from out-of-school visits thus the intention of the study to investigate what knowledge is gained during the visit. Field trips to out-of-school settings such as museums¹, aquaria, science centre and

¹ Museum is used in the broadest meaning of any out-of-school setting such as a visit to industrial site.

industrial sites contribute in different ways to the learning of science and may demonstrate some science concepts that require a complex machinery (Braund & Reiss, 2006).

Several studies report that out-of-school settings enhance learning due to experiences that arouse learners' willingness to learn (Kisiel, 2005; Jarvis & Pell, 2005; Lelliott, 2007). Additionally, a well designed field trip may lead to new learning or reinforce what is already learnt (McPeak, 2009). Informal learning is effective for science education because concepts may be learned within a natural setting, while formal education removes science from a natural to an artificial environment (Zoldosova & Prokop, 2006). In the natural environment, pollution and water purification are learnt through the concrete experience thus engage learners into abstract conceptualization (Lewis & Williams, 1994).

Through observations and interpretation of the experiences in outdoor visits, learners may construct knowledge through the use of their five senses (Lorsbach & Tobin, 1992). For this reason, taking learners to out-of-school is a constructivist approach in which learners are not considered as passive receivers of information but are actively involved in learning (Scott, Asoko, Driver & Emberton 1994). Out-of-school setting is a form of experiential learning that may assist learners to modify their existing knowledge in a light evidence gathered through learners' senses unlike in the science classroom where sense of hearing is prominent than others.

1.2 Background and the Rationale of the study

In Lesotho, taking a field trip to the out-of-school setting is an annual practice by some schools meant to entertain learners. Teachers in this case might not be aware that even though the trip is not for educational purposes, learning occurs. For instance, when I was in Form E, students each year were engaged in a trip to Katse dam. However, learners were never told the educational part of the trip even though it helped us later to answer some questions in General Certificate of Education Ordinary Level examination. It is then my interest to investigate what knowledge is gained as a result of organized educational field trips to WASA. Water pollution is a serious threat in Lesotho and leads to water borne diseases such as typhoid and cholera (Water and Sewage Authority Annual report, 2008). Diarrhoea is the most prevalent disease in Lesotho due to the poor storage of water

and lack of knowledge in some parts of the community of rural areas (Daniels, Cousens, Makoa, Feachem, 1990).

The resolution to this problem may reside in providing education that gives out the appropriate information about water quality in a meaningful way (Riskowski, Todd, Wee, Dark and Harbor, 2009). For instance, some people may measure the potable water by the absence of impurities and the taste. Potable water is defined as safe drinking water with no chemicals or bacteriological contaminants (Gadgil, 1998). However, Andreas (2007) states that clear water can carry disease organisms or toxic chemicals and taste is not the good indicator of safe drinking water. The stated ideas could well be addressed by taking learners to sites such as WASA that deal with water purification. Additionally, water pollution is one of the crucial topics in the syllabus that Basotho learners need to engage with because Lesotho earns money through exporting water. Therefore, learners should know how to take care of this important natural resource. Not all people in Lesotho have access to clean water but knowledge communicated at WASA may enlighten learners on what quality water is.

Activities at WASA include the show of chemicals such as chlorine used in water purification and is passed from one learner to another, the observation of steps involved in water purification and sewage treatment. The observation of real experiences at this place engages learners in authentic science (McGinn & Roth, 1999). It is therefore my interest to find out if authentic learning enhances knowledge acquisition as McGinn & Roth suggest. Additionally, outdoor visits may expand learners' knowledge when teachers have a precise purpose for bringing learners to museums (Griffin & Symington, 1997). Sometimes the teacher can fail to take advantage of exhibits at museums, not being aware how they contribute to educational systems. It is therefore my motive in this study to investigate activities at WASA that contribute to knowledge acquisition about community health.

1.3 The problem Statement

Field trips to industrial sites are increasingly adopted by several schools in Lesotho due to their potential in demonstrating environmental issues such as water pollution. The scenario is similar to Israel where learners appear to be frequent visitors to science centres in an attempt to enhance learning of science (Tal, Bamberger, & Morag, 2005). Having noticed that formal science learning is complemented by field trips, it is crucial to know what knowledge learners gain from such visits that cannot be gained in the classroom.

More studies focus on teachers' views about field trips to museums, but little on what knowledge is acquired during the visit. It is therefore my interest to know what knowledge is gained during the visit and what aspects of the visit contribute to learners' knowledge about community health. The findings of my study would inform other teachers on how field trips to WASA deepen learners' knowledge and what to consider for effective learning to occur at this place. It is also by the findings of the study that WASA authority would be aware of their contribution to science education and how to improve for the visits to WASA to be more meaningful to learners. More-over, studies about the impact of museums in science education have been done in countries such as South Africa, Canada, Australia, United States of America, Singapore, Israel, Germany and United Kingdom. It is therefore of the great interest to find if the findings attained from the stated researches will be similar to the ones found from the context of Lesotho. If similar, they could be incorporated in science curriculum and be adopted for the improvement of science field trips in Lesotho.

1.4 Aims of the study

The aims of this study were to (a) Explore what knowledge is acquired by learners during a visit to WASA, Maseru, Lesotho. (b) To investigate the aspects of the visit that foster knowledge acquisition about community health. The study required to investigate the following questions.

- To what extent does Form D learners' knowledge change as a result of a visit to WASA?

- What aspects of the visit influence learners' knowledge about community health?

1.5 Conceptual framework of the study

In this study, conceptual change is used to describe knowledge gained during the visit to WASA. Banet & Ayuso (2000) state that conceptual change is comprised of conceptual capture and conceptual exchange while Vosniadou (1994) states that enrichment is the simplest form of conceptual change. There are conditions that initiate conceptual change and these are: Intelligibility, plausibility and fruitfulness (Posner, Strike, Hewson, & Gertzog, 1982). These conditions are explained precisely in chapter 2 section 2.4.2. For conceptual capture and enrichment to occur, the new idea has to be plausible to the learner, that is the new knowledge has to relate to existing knowledge in order to reconcile. With conceptual exchange, the new idea should be fruitful to the learner for the existing ideas to be replaced. Since my study is concerned of what knowledge is gained during the visit, Griffin's (1998) model has been adapted to identify the aspects of the visit that influence learners' knowledge about community health. In this model, factors that contribute to outdoor learning are used to identify the aspects of the visit that may foster knowledge gain. The significance of prior knowledge appears in both models used in analysis of the data because new knowledge is meaningful when related to what is already known (Piaget, 1964).

1.6 Organization of the research report

This research report has five chapters. Chapter 1 provides the introduction and background to my research. Chapter 2 is a discussion of the literature on museums, misconceptions and theoretical frameworks for the study. Chapter 3 is an explanation of my research methodology and research instruments, methods used in data collection, ethics consideration and validity of the research. Chapter 4 is the analysis and the discussion of the collected data. Chapter 5 shows the findings of the research with implications in view of learning within out-of-school context.

Chapter two

Literature review

2.1 Introduction

The literature review is comprised of three sections: learning from out-of-school context, learners' misconceptions about community health and theoretical framework. This study investigates knowledge acquired as a result of a visit to a water and sewage treatment plant at WASA. At WASA, water purification, pollution and sewage treatment are demonstrated. Therefore, WASA appeared to be the good site for learning about community health in out-of-school setting. Conceptual change is the theoretical framework that guides my study and is discussed in the last section of this chapter. A visit to WASA is an example of out-of-school context and there are many misconceptions that are associated with water sources and purification. This literature review will therefore look at what research says about knowledge acquisition during learning in out-of-school setting.

2.2 Learning from out-of-school settings

Learning from out-of-settings occurs when learners are taken in out-of-school vicinity in exploration of concepts of interest such as learning at the museums or science centres (Eshach, 2006). The information in out-of-school context is conveyed to learners as to understand nature unlike learning of scientific facts in four walled classrooms (Pedretti, 2002). Therefore, the visit to WASA may enhance knowledge acquisition about water purification and pollution as learners will come in direct contact with the stated concepts. With out-of-school context, constructivist approach may be adopted in which learners are not considered as passive receivers of information. This is because learners may engage their senses (Lorsbach & Tobin, 1992) in exploration of concepts discussed therefore can construct their own knowledge on what they see not only on what they hear from their teachers in science classroom.

Learning in out-of-school context such as the visit to WASA may be good for demonstration of 'big' science that needs special equipment not found in school laboratories. In consideration of learning outcomes of community health, WASA seemed to portray the 'big science', demonstration of water purification and sewage treatment on a large scale. Apart from that, Eshach (2007), Lelliott (2007), and Rennie & McClafferty (1995) found that learners enjoy learning concepts at museums where hands on activities and exhibits stimulate learners' interest.

Exploring scientific concepts in out-of-school context may be exciting than when concepts are explained in the science classroom. Zoldosova and Prokop (2006) found that taking learners to out-of-school context increases learners' interest to study therefore cognitive gain enhanced. This indicates that motivation plays a vital role in knowledge acquisition. Falk & Gillespie (2009) also found that learners with more interest in learning acquire more knowledge than learners with neutral motions. Lelliott (2007) and Piscitelli & Anderson (2002) contend that learners find outdoor learning exciting thus willingness to learn is increased. This may also result in an increase in the number of learners doing science. Besides that, Salmi (2003) adds that learning within out-of-school context not only deepen learners' knowledge but can influence learners in science related carriers. However, DeWitt & Storksdieck (2008) warn that teaching complex topic should not only be done through museum visits for effective knowledge acquisition. Instead, a visit should intend to compliment formal learning through exploration of real experiences and first hand information. Therefore, complex concepts should first be explained in the classroom and elaborated further in outdoor visit to enrich gained knowledge. Pedretti (2002) adds that formal and informal learning should not be compared instead should complement each other for the effective knowledge gain.

Out-of-school setting is useful in instances when there are no facilities within the four walled classroom to clarify concepts. Therefore, informal learning may support the school curriculum. Knapp and Barrie (2001) found that learners taken in out-of-school setting for different programs showed a significant knowledge gain because of the availability of facilities. The community health section of the Lesotho biology syllabus covers aspects of daily life issues such as sewage and water treatment. These issues are real and cannot be

explored within the four walled classroom. Therefore, a field trip to WASA can be used to clarify the stated concepts and may foster knowledge gain.

Not only does outdoor learning assist learners to be in direct contact with a phenomenon under discussion but supplements information acquired in science classroom. Dillon *et al.* (2006) maintain that a well planned and effective fieldwork acquaints learners with skills and knowledge that embrace learners' everyday experiences in classroom. For this reason, formal and informal learning should not be separated for effective knowledge acquisition. This is congruent with Braund and Reiss (2006) that out-of-school context should aim to complement school-based learning. Learners knowing the purpose of the visit may be able to link knowledge communicated during the visit to classroom instruction thus acquire knowledge (Mosabala, 2009). Again, fruitful outdoor visit is attained when learners know the objective of the visit and concepts not isolated from the curriculum (Mosabala, 2009).

Concepts explained through direct contact and manipulation may be more meaningful than information offered verbally in the classroom. In support of this, Hofstein, Kesner and Ben-zvi (1999) show that learners exposed to industrial chemistry or biology find chemistry and biology more relevant and applicable than learners doing those subjects in the classrooms. Riskowski *et al.* (2009) add that learners exposed in real life situations when dealing with engineering project acquired knowledge more than learners in science classroom. Outdoor learning in this notion seems to bring abstract concepts into concrete explanations hence conceptual clarification attained. Besides that, group of students in Hofstein & Rosenfeld (1996) study that was engaged in several geological field trips out competed a control group of students doing ecological concepts in the classroom. Knowledge gain is determined by the aspects of the visit in out-of-school visits thus this study investigates what those aspects are.

Learners tend to remember field work and information communicated during out-door visits for a longer period of time (Dillon *et al.*, 2006). In most cases memorable exhibits may be easily remembered and enhance knowledge gain (Anderson & Lucas, 1997). However, simply remembering the visit or the field work may not denote the conceptual understanding but acquisition of scientific facts due to learners' good memory.

This category of knowledge acquisition is called addition since new facts are added to learners' existing knowledge (Lelliott, 2007).

The information could be held for a longer time but not used to solve other problems since it is memorized and not understood. A learner therefore can remember what the visit was all about but fail to connect it with school-based instruction. Lelliott (2007) also found that learners were able to remember the experiences of the visit because of the good memory. Therefore, learning in out-of-school context should go along with school based instruction for learners to extend what they remember from the visit with information communicated in the classroom. Even though outdoor learning develops cognitive skills than classroom-based learning (Eaton, 2000), it does not always benefit learners on its own. Therefore, a link between the world of school and of physical surrounding is necessary for knowledge acquisition. This imposes that both informal and formal learning are important for better understanding of science concepts.

There are different learning styles in science classroom and using one learning style may hinder knowledge acquisition amongst other learners. In most cases learning style preferred by majority of the class may be the one predominantly used thus minority ignored (Dowdeswell, 1981). Therefore, taking learners to out-of-school setting can broaden the choice of learning because of the presence of verbal and visual learning styles through listening to tour guides, hands on activities and demonstrations during the visit. McPeak (2009) maintains that education in out-of-school context offers a multi-sensory learning environment. Therefore, knowledge communicated during the visit may be acquired by learners of different learning styles. Again, learning in out-of-school context is said to meet the interest of learners with what Dillon et al. (2006 p. 109) termed low 'disgust sensitivity', referring to learners interested in manipulation of objects. However, learners not interested in touching of the objects are found not to gain much knowledge when the visit is highly orientated on hands on activities (Dillon *et al*, 2006). Therefore, learning in out-of-school context may portray a learner centered approach in which learners' differences are catered for.

A well organized outdoor learning should not regard learners as passive receivers of information. It should engage theory into practice to qualify as experiential learning and should be able to make analysis of everyday life experiences in light of real situations as to attain meaningful learning (Lewis & Williams, 1994). As an illustration, learners may not understand why water pollution is a concern yet companies such as WASA purify water for domestic use. However, being exposed to several steps of water purification may inform and make learners aware that water treatment is not a minute-made process and needs money. Additionally, not only water pollution threatens aquatic life but increases the cost of living due to the fact that more chemicals are needed for purification of more polluted water. Learners may not see how aquatic life is useful in their lives but may only see its end product. For instance fish lives in water and is affected by pollution but learners may not understand that water pollution directly decreases the production of fish that they see preserved in the markets. Therefore, outdoor learning about pollution at industrial sites such as WASA adds realism in clarification of the effects of water pollution. Direct contact with the environment and real situations offer relevance and motivation amongst learners thus environmental concern and awareness fostered (Job, 1996).

Water is not a limitless resource and should be used without compromising the needs of the future generations. For this reason, exploring water pollution through direct contact may influence learners to make informed decisions when using water. Fien and Gough (1996) maintain that outdoor visits better explore environmental issues than teaching concepts within the science classroom. Therefore, taking learners to industrial sites such as WASA may make learners realize that water does not come automatically from the tap and should be used sustainably. Learners realizing that water is directly drawn from the river may get the evidence that rivers are water sources not only for animals but also for human beings. Therefore, with knowledge attained in out-of-school context, awareness about pollution can be raised thus environmental friendliness fostered.

Community health as stated earlier, is comprised of environmental concepts such as pollution and water purification. With the environmental education teaching techniques, the concepts can be taught in three ways; 'in' the environment, 'about' the environment and 'for' the environment (Fien, 1993). With education 'in' the environment, the teacher adds the realism on the environmental concepts taught (Fien & Gough, 1996). For example, learners may view water purification on the text book version but cannot connect their understanding with the fact that water flowing in rivers is treated and used daily. However, taking learners to real life situation gives evidence to what the text books illustrate that river water is purified for domestic use. Learning in out-of-school context is similar to education 'in' the environment and offers experiential learning in which real situations are explored (Fien & Gough, 1996). Similarly, the visit to WASA explores water purification in the experiential manner in which learners observe the processes. In this scenario, learners interpret what they encounter through their own experiences (Anderson et al. 2002).

Out-of-school settings as previously stated should act as the backup or provide evidence for the information communicated in the classroom. In this way, conceptual change may occur based on the status of the existing ideas with respect to the new knowledge (Carr, Baker, Bell, Biddulph, Jones, Kirkwood, Pearson & Symington, 1994). Apart from that, learners exposed in real science (McGinn & Roth, 1999) may be able to participate within the community as the problem solvers. It is therefore important for both informal and formal education to be practiced at schools.

Outdoor observations in science learning may result in meaningful learning since learners are exposed to natural setting where concepts of interest are real. Brown, Collins & Duguid, (1989) add that knowledge that is situated on the context is developed within. Therefore, learning within the right environment results in effective knowledge acquisition. With this notion, learners at WASA observing steps involved in water purification may gain knowledge more than learners in science classroom. Again, observation of real experiences may confront learners' naive ideas as they talk and discuss about the concept under study. Learners may acquire knowledge through the assistance of other knowledgeable learners while observation of concrete experience engages learners in

abstract conceptualization (Lewis & Williams, 1994). Additionally, with observation, learners go beyond knowing the scientific facts from the text books and construct knowledge hence scientific thinking developed (Hawkings & Pea, 1987). Moreover, observation in out-of-school context can allow learners to come up with their own views while the teacher and the tour guide act as facilitators.

Through talking and asking questions, learners may be able to communicate their thoughts and possibly be assisted by the tour guides to gain accepted knowledge of science. This is in line with Mercer's (1994) assertion that through talking one is engaged in a social mode of thinking. Even though outdoor visits are flexible, the tour guide is needed to facilitate learning. It is therefore crucial for learners to go through the observations in the presence of the tour guide if the visit is to benefit learners. Taylor, Muller & Vinjevold (2003) add that group work may not benefit learners from poor background with community code (language used at home). It is therefore, highly possible for the learners to reinforce their misconceptions in the absence of either the teacher or tour guides when observations are made. For this reason learners should observe the natural phenomenon with the assistance of the knowledgeable person either being the tour guide or the teacher.

2.2.1 The contribution of Prior knowledge in knowledge acquisition.

Prior knowledge is attained from school or daily life experiences (Chi, 2008). Textbooks when clearly comprehended may acquaint learners with prior knowledge in line with accepted knowledge of science. It is therefore evident that learners cannot attend the visits as empty vessels and acquiring knowledge during the visit depends on what they already know. Griffin (1998) adds that it depends on what the learner already knows for the new information communicated during the visit to be acquired. Since learners come to science learning grounds with their own knowledge influenced by their traditional beliefs (Duit & Treagust, 2003), information in out-of-school context should relate to what learners already know. Therefore, activities and exhibits during the visit should intend to have an effect on learners' existing ideas either raising or lowering held ideas for conceptual change to occur. Experiences and activities in out-of-school setting should assist learners to gather evidence that support accepted knowledge of science (Scott *et al*, 1994). As an illustration, learners may regard river water as only useful for people in the rural areas

even though river water is treated and used for domestic purposes in urban areas. So taking learners to WASA may give evidence about water sources and water purification processes.

Prior knowledge can either hinder or allow learning depending on the alternative concepts held by the learner (Mikkila-Erdmann, 2000). For example, Henriksen & Jorde (2001) found that students with strong alternative conceptions were not able to acquire knowledge from the exhibition that provided science learning. Religious, cultural and science worldviews are different and can interpret a certain phenomenon differently (Roth & Alexander, 1997). Therefore, a learner with a strong worldview other than that of science may experience the problem in accepting the science knowledge thus science learning hindered (Moletsane, 1995). Apart from that, learners with little prior knowledge in line with a concept under discussion gain factual knowledge with minimal cognitive gain while learners with greater prior knowledge differentiate and extend their existing knowledge (Lelliott, 2007).

Even though Lorschach and Tobin (1992) affirm that learners use their five senses to construct knowledge in their minds, it is evident that prior knowledge contributes in the building of this new knowledge. An understanding of the new knowledge depends on what the learner already knows as to restructure or modify the existing knowledge (Vygotsky, 1978). This is similar to DeWitt and Storksdieck (2008) assertion that cognitive learning is influenced by learners' prior knowledge. Therefore, linking the new information with what is already known develops ones' understanding (Griffin, 1998). In this way, learners more familiar with water purification may be expected to gain more knowledge than learners with limited prior knowledge about water treatment.

Learner's prior knowledge is the crucial part in outdoor learning for it may show if the new knowledge has been acquired or not (Halpern & Hakel , 2003). It is therefore important in this study to investigate what learners know about community health before going to the visit hence pre-questionnaire developed in this study. In this scenario, learners with concepts in line with accepted knowledge of science may better acquire information communicated during the visit. This is because learners may only enrich the information that is already held and can even extend it to solve other problems thus conceptual

understanding revealed. Conceptual exchange in this notion is not required since only missing components are added (Banet & Ayuso, 2000). Similarly, learners with scanty knowledge acquire the new knowledge through addition as they do not rectify existing knowledge and conceptual exchange is also not necessary.

Interactive exhibits and hands-on activities assist individuals to construct knowledge in relation to what is already known (Jarvis & Pell, 2005). This indicates that even though teachers regard visits to these out-of-school-settings as a way of improving science at schools, learners should be familiarized with the concepts that will be dealt with before the visit (advance organizer). Anderson and Lucas (1997) add that learners not familiar with exhibits do not attain higher cognitive gain as compared to learners orientated about the objectives of the visit and the content beforehand.

2.3 Learners' misconceptions about community health

A misconception is naive knowledge that is resistant to change (Hewson, 1981) while preconceptions or alternative conceptions may sometimes be revised through instruction (Chi, 2008). Water pollution and purification are concepts in community health well presented at WASA. However, learners develop ideas about these concepts before the topic is taught at school thus misconceptions are encountered. For example, McPeak (2009) affirms that learners are not aware of the long processes undergone to purify water and regard water as a limitless natural resource automatically accessed from the water taps. This defies a scientific fact that water is collected from the water sources and purified for good quality. Apart from that, learners believe that clear water without suspended solids is safe for drinking (McPeak, 2009). In this case, learners are not aware that harmful germs such as bacteria in untreated water are not seen with a naked eye. Besides that, learners are also not aware that clear water may also contain dissolved chemicals that are harmful to the body. For example Bissen & Frimmel (2003) pointed out that chemicals such as arsenic (an element found in substances such as fertilizers) are poisonous but cannot be seen suspended in water. For this reason, taking learners to WASA may improve learners' understanding of why water needs to be purified and why water has to undergo so many different stages of purification before it is declared safe drinking water. Additionally, Riskowski *et al.* (2009) found that learners have a misconception that

chemical pollutants are killed for a safe drinking water. In this way, learners perceive chemicals as living organisms to be killed for good water quality. Whereas, only microorganisms are killed for safe drinking water. Addition of chlorine at the last stage of water purification may enlighten learners through a direct experience that organisms though not seen with a naked eye in water are killed during the water purification process.

2.4 Theoretical framework

2.4.1 Conceptual change.

In this study, conceptual change theory is used to investigate the impact of the visit to WASA. Conceptual change is a learning theory that explains how existing conceptions such as beliefs or ideas are changed to accepted knowledge. Under this theory, a constructivist approach in which learners are engaged in active role of reorganization of their knowledge is required (Chi, Slotta & de Leeuw, 1994). Learners' existing knowledge is not overlooked but used as the base for acquisition of new knowledge. Piaget (1964) maintains that new knowledge is understood in relation to existing knowledge. This is called assimilation, the process of taking in the new information into existing schema. During this process, new knowledge is understood or makes sense to individuals when it relates to existing ideas (O'Loughlin, 1992). My study is therefore guided by conceptual change theory because it takes accounts of what the learner already knows. Mikkila-Erdmann (2001) asserts that acceptable knowledge is gained when learners are aware of misconceptions from previously acquired knowledge. The conceptual change theory is therefore used to define knowledge gained as a result of the visit to WASA.

Conceptual change theory is used in my study though other researchers such as (Falk & Dierkings, 2000 and Lelliott, 2007) regard constructivist perspectives to better explain how learning occurs in out-of-school context. Nevertheless, Abd-El-Khalick & Akerson (2006) point out that constructivism fails to explain how learning occurs as much as conceptual change does, and cannot be put to empirical test. In other words, constructivism explains how learners negotiate meaning from the world but cannot be measurable as conceptual change is. In this case, my study overlooks constructivism and concentrates more on conceptual change. Therefore, learners are not examined on how they construct knowledge but how a visit to WASA contributes in knowledge gain about

water and sewage treatment and how aspects of the visit encourage change in learners' existing knowledge.

Conceptual change can be fostered in several ways such as enrichment, conceptual capture and conceptual exchange. With enrichment, information is added to the existing idea to make it more clear and comprehensible but existing ideas are not restructured. Enrichment occurs when the existing knowledge is in line with accepted knowledge of science and considered the simplest form of conceptual change (Vosniadou, 1994).

In conceptual capture, learners' existing ideas are partially correct and modified while in conceptual exchange misconceptions are replaced by accepted knowledge of science (Banet & Ayuso, 1999). It therefore shows that conceptual change relies on what the learner already knows. Chi (2008) argues that in enrichment, gaps are filled and the missing components are added. As a result, enrichment does not constitute conceptual change because in conceptual change, misconceptions are rectified into accepted knowledge. I consider enrichment to be part of conceptual change since missing information is added to make description of concepts more comprehensible. For instance, when the learner says 'boiling kills germs' and later the learner says 'addition of chlorine to water and boiling kill germs'. The first statement is correct but for the second time is added with the new information that chlorine can also kill germs. I therefore consider Vosniadou (1994) definition that enrichment is the simplest form of conceptual change.

Learners may give the wrong definition of the concept due to a lack of knowledge but that definition can slightly be restructured after the new knowledge is acquired and that is called conceptual capture. As an illustration, the learner says 'water has diseases', but later the learner says 'water has disease causing germs'. The first statement has been slightly modified to make the response correct. It therefore shows that with enrichment the response is correct but added with another information to make it more meaningful, while in conceptual capture the partially wrong answers are corrected.

When the existing idea is wrong and is resistant to change to accepted knowledge of science, it is called a misconception (Banet & Ayuso, 2000). In this state conceptual exchange is required in which the in-depth modification of the idea is done. For instance

when the learner says ‘water automatically comes from the tap’, this is a wrong statement that might be resistant to change thus needs in depth modification thus conceptual exchange needed. For conceptual exchange to occur, learners have to be aware of their misconceptions (Chi, 2008). Learners’ prior knowledge is crucial in all the stated types of conceptual change. It is therefore crucial in this study to investigate what learners already know before the visit to WASA. Enrichment and conceptual capture are used to describe learners’ responses on the questionnaire and the interviews.

There are three conditions that foster conceptual change and those are when new knowledge is intelligible, plausible, and fruitful (Posner et al. 1982). These stated conditions will be used in my study to describe gained knowledge from learners’ questionnaire and interview responses. With intelligibility, a learner accepts the idea because it makes sense but does not relate it to what is already known while plausible ideas tend to relate with existing ideas and are accepted by the learner to be sensible and used to solve other problems. With regard to fruitfulness, the concept can be extended and be used to negotiate meaning from other experiences (Posner et al.1992). For instance, the learner may say water pollution does not only affect aquatic organisms but indirectly affects the economy of countries that rely on production of organisms such as fish. This indicates that the learner conceptualized the idea that water pollution is not only bad for organisms in water but even to people that may be causing it. In conceptual exchange the new idea should first be intelligible, plausible and lastly be fruitful fostering modification or reorganization of existing knowledge. However the idea cannot always attain the three stated conditions, meaning it can be intelligible but not be plausible to the learner. It is when the idea has undergone all three conditions that conceptual exchange occurs (Posner et al. 1992). However, for enrichment and conceptual change to occur, the new idea has to be plausible to the learner (Hewson, 1981).

As stated earlier, strong alternative concepts inhibit the acquisition of new knowledge therefore a learner can regard the idea as intelligible though he could not use that idea to solve other problems. However, Henriksen and Jorde (2001) found that out door visits have the potential of eliminating learners’ held misconceptions. Learners might not know the importance of many steps involved in water purification. However, being in real

contact with water purification processes may assist learners to realize that each step has its own importance to have water safe for drinking. In this situation, learners make judgments based on concrete evidence (Posner *et al*, 1982). The three stated conditions of conceptual change identify how the new knowledge is accepted into existing knowledge. Therefore, the new knowledge has to satisfy one, two or all of the three conditions before it is incorporated into existing knowledge. These conditions align with the idea that learning occurs when the unknown is related with the known. Therefore, learning depends on learners' prior-knowledge (Hewson & Hewson, 1984). It is therefore important for teachers and the outdoor educators to take account of learners' prior knowledge to facilitate knowledge acquisition during the visit.

Griffin's (1998) model is adapted (modified) for use in my study. It shows factors that contribute to learning in out-of-school settings. The factors include museums (out-of-school setting), children (learners) and teachers as illustrated in the figure below.

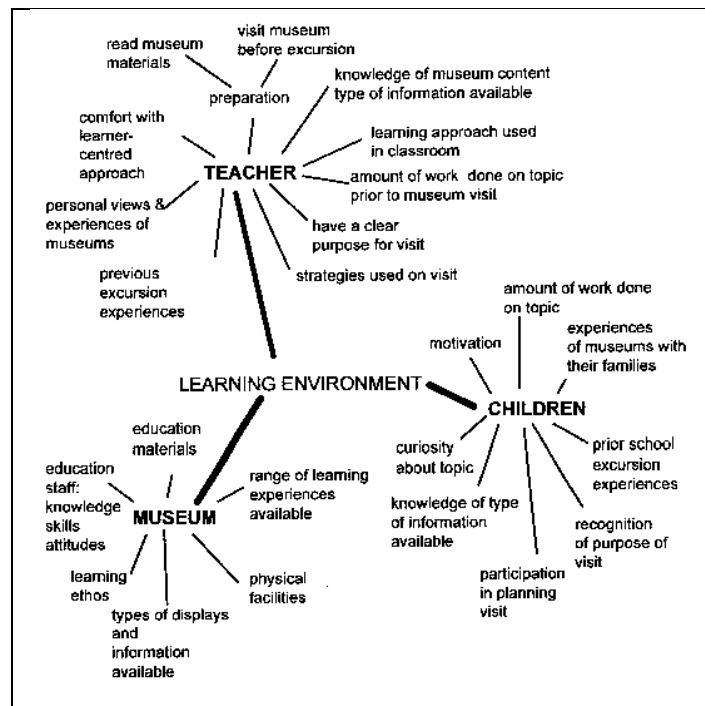


Figure 1.1 Factors which may determine the learning environment for school groups visiting museums (Griffin, 1998: p4).

My study however is focused on out-of school setting and children. Therefore, the modified model in figure 1.2 below is comprised of out-of-school-setting and the learner only. The model illustrates factors that contribute in learning in out-of-school setting. It is not only taking learners to the visit that enhances learning but the place of visit should portray attributes that make the impact in science learning and those are physical facilities, type of display and experiences available. Similarly, factors that determine learners' ability to acquire knowledge in out of school context are explored. Those are prior knowledge, experiences during the visit and participation during the visit. These factors are explained in the leading paragraphs but prior knowledge is elaborated in section 2.2.1.

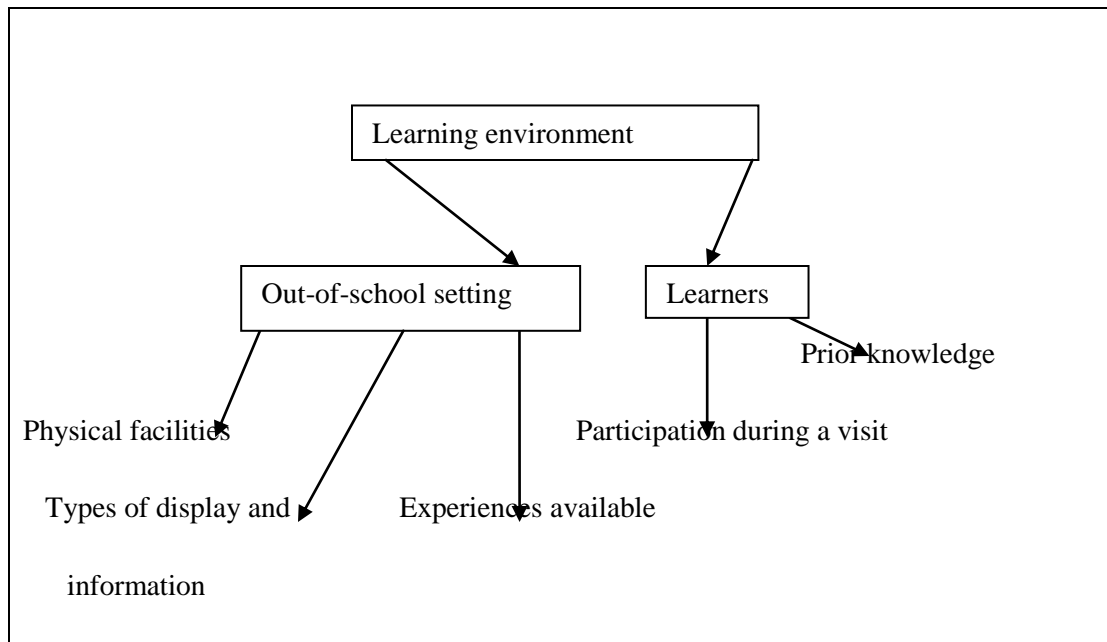


Figure 1.2: factors that contribute to learning in out-of-school-setting (After Griffin, 1998).

Participation during the visit: participation denotes that learning is not individual and should not be regarded as the transmission of scientific facts, rather a social process where knowledge is co constructed (Lave, 1996). According to Lave and Wenger (1996), participants gain knowledge and novices end up as experts. Therefore, learners engaged in activities at WASA may acquire more knowledge than learners participating in science classroom with no direct contact with phenomenon under discussion. In this scenario, learners exposed in experiential learning could possibly be active problem solvers in their

community. Participation is noticed when one is taking part or doing things with others or getting involved in a certain task. However, observation and interaction among learners and tour guides are forms of participation that dominate activities at WASA. These forms of participation promote knowledge acquisition as learners share the ideas with others and ask questions. Learners' interaction during the visit may enhance knowledge acquisition as Vygotsky (1978) contends that learning is social. In this notion, knowledge is acquired as learners talk to each other and to the tour guides about the concept under discussion through direct experience.

Types of display and information: Visual displays play a vital role in explanation of abstract concepts and therefore influence learning in out of-school-setting (Griffin, 1998). For instance, there is a chart at WASA that demonstrates seven steps involved in water purification. It is at the beginning of the tour that the tour guide explains those steps demonstrated on the chart thus acted as the advance organizer. The information on the chart together with the explanation by the tour guide educator informs learners of the purpose of the visit. Learners are also given the chance to ask questions in relation to the demonstration on the chart.

Experience of the visit: Experience refers to knowledge encountered such as how water is purified at WASA of which learners get the real experience on water treatment processes. With that experience learners may develop observation skills hence able to engage in scientific thinking. Drawing river water to be purified at WASA may be the new experience for some learners who only know taps as their source of water. Therefore, this experience may give evidence to science knowledge that rivers are water sources and water does not come automatically from the taps. Tomkins and Tunnicliffe (2001) found out that the direct experiences contribute to better understanding of concepts under discussions. The experiences at WASA demand learners' observation skills when scientific concepts such as water purification are demonstrated. Therefore, the realism of the concept discussed is revealed and illustrations from the books can make sense. Henriksen and Jorde (2001) outline that environmental experience give learners an opportunity to be part of environmental activity. As a result, exploration of pollution at the

river water to be treated at WASA may influence learners to respond positively on activities striving to keep the Lesotho environment clean.

Physical facilities: Physical facilities at WASA would be the Mohokare river, machinery used in water treatment and chemicals used during the process. Griffin (1998) outlines that the availability of the physical facilities contribute to effective outdoor learning. Therefore, physical facilities should make a place suitable for demonstration of concepts of interest. WASA because of its machinery used in water treatment makes learning about water purification and pollution relevant. Brown *et al.* (1989) add that knowledge is situated in the context, it is therefore the availability of facilities at WASA which makes it a suitable place to learn about environmental issues such as pollution and water purification. There is a river near WASA of which the machinery is placed to draw water to other machineries in water purification process. In this scenario, learners get evidence that water is indeed drawn from the rivers, purified and supplied to water taps. In this case, learners' existing ideas that water comes automatically from the tap may be restructured depending on how intelligible the new idea is. With evidence gathered at this place learners may restructure their existing knowledge to accepted knowledge of science. The machinery and chemicals used in water treatment are shown to learners and the process of purification observed. As a result, learners may be aware that water purification is a long and costly process especially when the river water is polluted since more chemicals are used. Physical facilities demonstrate the big science which is not available within the school vicinity due to the absence of the machinery and should therefore facilitate knowledge gain.

2.5 Conclusion

This chapter looked at the importance of informal learning in science education and the attributes that make learning in out-of-school context a success. Learning from out-of-school context allows learners to be in direct contact with the concept of interest and may conceptualize abstract concepts. Learners' misconceptions have also been discussed in relation to community health. Alternative conception and misconceptions are different in that misconception are resistant to change while alternative conceptions are not and may be corrected easily through instruction. Conceptual change theory guides this study and is

explained in this chapter as the change of naive knowledge to accepted knowledge of science. The importance of prior knowledge is outlined from the use of conceptual change theory and is also explained in details in this chapter. The following chapter discusses the research design and methodology used in this study.

Chapter Three

Research design and Methodology

3.1 Introduction

This chapter discusses the research methods, instruments, the methods used in selection of the sample and data collection in this study. The ethics consideration, reliability and validity of this research re also discussed. The literature relevant to the methodology used in this study is also reviewed.

3.2 Methodology

This study investigated the impact of a visit to WASA on learners' knowledge about community health. The aspects of the visit that influence learners' knowledge about community health were also considered. The following questions were investigated

1. To what extent does learners' knowledge change as a result of a visit to WASA?
2. What aspects of the visit influence learners' knowledge about community health?

3.2.1 Research design

When looking at the research questions and the problem under study, this study falls under qualitative case study in which interpretation and description of the phenomenon are done in a natural setting (Golafshani, 2003). In this study, learners were taken to an outdoor learning at WASA, a natural setting in which water purification and the effects of pollution are demonstrated. According to Denscombe (2007) case studies investigate in-depth either one or few instances and this suits my study since it investigated the impact of the visit to WASA on a particular group of learners. Opie (2004) maintains that a case study investigates the real situation of a person or a particular group of people and the attributes that influence that situation. The purpose of this study is to investigate the impact of the visit to WASA on learners' knowledge about community health. Therefore, a case study suits this investigation since the aspects of the visit influencing knowledge gain are investigated in the natural setting, particularly looking at group of form D learners studying Biology.

This study is a qualitative study because of the outlined features in this paragraph. The study has been conducted on form D learners as Opie (2004) maintains that case study is conducted on real people. In other words, the case study involves the concrete experience as learners were exposed in real situation of water treatment at WASA. In analysis of the collected data, numeric presentations were minimally used while interpretation and description were greatly used to give meaning to the collected data. This is in line with Merriam (1998) description that qualitative case study is not statistical in nature. Qualitative and quantitative methods were not mixed in this study as Kalil, Yoshikawa, Way & Weisner (2008) contend that they show equal status when mixed. A full description of the extent at which learners' knowledge change as a result of the visit to WASA has been provided.

Qualitative research means the method of inquiry in which the words instead of numeric representation are used (Kalil *et al.* 2008). The study investigated the impact of the visit to WASA and the description by words have been used in an attempt to explain when, what and how knowledge has been acquired during the visit. Bogdan and Bilken (2003) support that qualitative approach explains when, how and under what situations the certain behaviour occurs. Additionally, the study stated the reasons why the findings appear in that manner and the researcher interpreted the results. Opie (2004) explains that in qualitative research, the researcher is the primary instrument and subjectively analyzes the data. As stated earlier, interpretation and description were used in analysis of the collected data while measurements and observation were not applied since it is a qualitative study (Merriam, 1998).

My study is on field work and is compatible with the characteristics of the qualitative approach in which the researcher personally goes to the field and collects data from the natural setting (Merriam, 1998). Knowledge gained from the collected data is the one used to deduce the meaning of the investigated phenomenon rather than testing the existing theories (Merriam, 1998). Therefore, the product of qualitative research is highly descriptive unlike positivists that are factual and orientated on theories and laws (Hatch, 2002). Moreover, qualitative approach is flexible in the sense that it allows the use of

more than one instrument hence triangulation attained (Opie, 2004). This is revealed in my study where two instruments in data collection were used for the first research question.

When categorised amongst the research paradigms, this study would be under qualitative interpretive paradigm since the researcher's interest is on experiences rather than testing a hypothesis (Merriam, 1998). The researcher has chosen the interpretive paradigm because the research is based on human beings not objects for the experimentation is not conducted on humans instead their behaviour is observed and interpreted (Merriam, 1998). In the positivist approach, data is directly experienced by the observer and given meaning based on knowledge gained from sense data (Cherry, 1998). In the interpretive paradigm, the researcher's values and interpretation give an explanation of the captured experiences (Opie, 2004). Similar to this study, observations were conducted as to capture experiences and the researcher's interpretation explained the captured experiences. However there are high chances of bias because the studied phenomenon could highly be expressed according to researcher's own views. The notion outlines the importance of objectivity in research though it is not easily attained in human research. The interpretive paradigm was then developed as an alternative approach in educational research (Opie, 2004). In the interpretive paradigm, the researcher goes through the collected data and looks for important information to make an informed description and interpretation of the data. Therefore qualitative approach is discovery oriented and not guided by predetermined categories while the subjectivity used is controlled by the collected data. In this study, the researcher read through the collected data and looked for important information as to make informed description and interpretation of the data. There were no predictions made in this study but reality was viewed through subjective perception as Merriam (1998) suggests.

3.3 Limitations of the case study

Even though case studies allow the in-depth investigation of the phenomenon, the collected data is prone to subjective analysis (Opie, 2004). This is because the researcher is the one giving meaning and description to data and this may result in lack of rigour. In this notion the researcher's interpretation could be too general with a limited number of people involved in the study (Merriam, 1998). However, this study was discovery oriented

and not controlled by the predetermined categories therefore subjectivity was controlled by collected data and the reported results were not general for they were based on eighty learners only.

3.4 Research instruments

This study used the following instruments to collect data: questionnaire, interviews and observations schedule.

3.4.1 Questionnaire

The pre and post questionnaire is developed with six and seven questions respectively. The questions constructed in both pre and post questionnaire covered the concepts of pollution and water treatment. The questions were the same for both pre and post questionnaire except for the number seven in the post questionnaire (see appendix 1). Opie (2004) states that a questionnaire is developed for a purpose, therefore the purpose of the questionnaire in this study was to find learners' knowledge before and after the visit to WASA. The developed questionnaire was unstructured that is participants were not provided with fixed responses to choose from, therefore responses were free (Neuman, 1994). The unstructured questionnaire made up of open-ended questions has been suitable in this study because of rich responses it offers (Opie, 2004). The questionnaire questions were formulated by the researcher in relation to the information communicated at WASA. The developed questionnaire has been useful in acquiring learners' prior knowledge that is different and depends on individuals' background. Therefore, the closed questionnaire questions would have left learners' responses aside. The questionnaire was developed to explore the research question that say:

- To what extent does learner's knowledge change as a result of a visit to WASA?

Opie (2004) states that the second language may hinder the detailed exploration of the phenomenon under study. English is a second language to learners involved in this study and learners may not have been able to express their thoughts on the paper. To avoid this, learners were asked to use their first language (Sesotho) in cases where they cannot clearly express themselves. However, none of the students wrote their responses in Sesotho but all responded in English.

3.4.2 Interviews

In conceptual conflict, learners ideas may contradict with accepted knowledge of science (Hewson & Hewson, 1984) which in this case is the knowledge communicated at WASA. The conflict may take two days or more (Hewson & Hewson) therefore an interview was conducted two days later to assess the outcome of the conflict, that is whether accepted knowledge of science is gained or not. The questionnaire may fail to answer why questions (Opie, 2004). Therefore, interview questions were developed in an attempt to detect verbally the knowledge gained from the visit to WASA as interviews stimulate recall (Allen, 2002). There was no interview schedule developed but the questions were developed in accordance with responses from question one, two and three of the pre and post questionnaire (see appendix 2).

3.4.3 Observation

The observation schedule used in this study was adapted from Cox-Petersen, Marsh, Kisiel, & Melber (2003). This is because their study is similar to my study, they wanted to know the aspects of the museum that contribute to knowledge acquisition. The following activities were noted in the observation schedule; manipulation, observing or listening and interaction. Manipulation will be denoted by (m), Observing/listening by (0) and interaction by (i). With manipulation, I looked at on-task behaviour that includes manipulating or touching of objects, while observing or listening considers any non interactive behaviour that includes observing or listening. Lastly, interaction looked at the talk between at least two people that include asking questions, explaining, making comments about the on-task behaviour (Cox-Petersen *et al*, 2003). The designed observation schedule was in a form of a table to show what learners and tour guides reveal in line with the stated codes, see appendix 3.

A group of twenty learners were observed during the tour as to investigate the research question that says:

- What aspects of the visit influence learners' knowledge about community health?

With regard to observations the information from the physical environment about the participants' behaviours is personally recorded by the researcher (Opie, 2004). Therefore,

observations may be influenced by the researchers' interpretation of the phenomenon under discussion. This is one of the scenarios in which the weakness of the qualitative research is exposed. To avoid this, the researcher relied on the observation schedule developed.

In observations unaware or purposely, the participants' behaviour may change. For instance, the presence of the researcher may influence learners not to interact with other learners or ask questions in the way they normally do in science classroom. However, the researcher visited the participant two days before the visit to give the brief explanation of this study. The researcher intended to be familiar with participants as to avoid unexpected behaviour that may be caused by the unfamiliar companion.

3.5 Reliability and validity

3.5.1 Reliability

“Reliability indicates the goodness or quality in research” (Opie, 2004. p.65). In this case, the trustworthiness is detected through the consistency at which the results are obtained under the different conditions. The research used the questionnaire as one of the instruments in data collection and was piloted before it was administered. This is the other way of making the research findings reliable through checking if the questionnaire questions are in line with research questions. The questionnaire was given to a group of learners of the same age and context to the targeted sample of the main study as to identify ambiguous questions and rephrase them. In other words the pilot study was not conducted to the sample used in the main research. This was done before the instrument was administered to the targeted group to check if it will work as anticipated.

Piloting reduces the non responding rate (Opie, 2004) since the questions in both the questionnaire and the interview was reworded for clarity. From the pilot study it was found that some learners did not understand what a ‘pit latrine’ is, for this reason **the researcher had to explain the word when the main sample was used**. The other question wanted the learner to explain how river water is useful to them. In this question, most learners mentioned that river water is used for farming purpose. This question was

modified for the main research, to say **apart from the farming purpose** how is river water useful to you.

Merriam (1998) asserts that reliability in research design assumes that there is one reality that could give the same results when studied for several times. In this study taking learners to WASA is the reality and investigating about its impact on learners' knowledge may repeatedly be studied by other researchers. Merriam further explains that reliability is also strengthened by the use of several methods in data collection and analysis and this is called triangulation. Triangulation is portrayed in this study since the questionnaire and the interviews were used to identify knowledge gain. Reliability directly affects the validity, that is if there is no consistency in the findings of the research the study is not valid (Maxwell, 1992). It therefore indicates that there is a connection between the reliability and the validity of the study. Merriam (1998) maintains that the study is more valid when it gives the same results from the repeated observations but this is not possible in the case study since subjectivity is used in the analysis.

3.5.2 Validity

Validity is when the instrument measures what it is supposed to measure (Opie, 2004). Two types of validity have been used in this study and these are: face and content validity. With face validity, the validity is determined by the expert looking for either content or construct validity. The Content validity is conducted to check whether the questions in the research instrument adequately covered the content needed by the research questions (Sanders & Mokuku, 1994). Both face and content validity were done by the expert in informal learning and the lecturer at Wits University in the field of natural sciences. The various changes were suggested and incorporated in the research instrument and those changes are:

- Mention the importance of boiling water changed to **some people have no access to clean water what is the purpose of them boiling water before use?**
- What do you think is the main reason for building of pit latrines for people by the Lesotho government changed to **Pit latrines are encouraged in Lesotho, what do you think is the purpose of this?**

- If you are to tell someone about the visit what would you talk about? Changed to **could you describe two things that you learned from the visit to WASA about**
 - a) **Water treatment**

3.6 Data collection

Three instruments described above were used to collect data. In the morning before the visit to WASA, the pre-visit questionnaire was administered in learners' classrooms for about thirty minutes. The researcher did not conduct people at WASA beforehand about the concepts they should discuss during the visit but allowed them to do what they normally do. The researcher with one subject teacher was welcomed by the tour guides at WASA. One group made up of twenty learners was followed by the researcher to observe what they do during the visit. After the visit learners moved to their school on foot and the post questionnaire was conducted in their classrooms using the first afternoon period. Two days later the interviews were conducted after the pre and the post questionnaire responses were read and compared.

3.6.1 Administration of the pre questionnaire

The questionnaire with the help of the subject teacher was administered to the learners in their classroom thirty minutes before the departure for WASA. This allowed the researcher ample time to make clarifications in an attempt to obtain high response rate (Bowling, 2005). Firstly, learners were reminded of the purpose of this study and asked to write their names and numbers on the separate sheet. This was done in case the researcher needs the clarification on learners' responses. Learners did not write their names on the questionnaire responses but only wrote their given numbers. The numbered responses in both pre and post questionnaire assisted the researcher to identify changes made from pre to post questionnaire. Learners asked the questions concerning the questionnaire questions and the clarifications were made. The researchers' presence when the questionnaire was administered assisted in avoiding discussion of the questions amongst learners that would lead to similar responses. Therefore a rich data was expected unlike when learners were not under supervision and write the same answers. Some learners were curious to know whether they would get marks for filling the questionnaire but the researcher explained

that it is not for the marks. This might have discouraged other learners to answer all questions hence some blank spaces were left.

3.6.2 Administration of the post-questionnaire

The visit to WASA took an hour and the post questionnaire was conducted soon after the visit. The post questionnaire was conducted at school in learners' classroom. The post questionnaire similar to pre questionnaire was administered by the researcher with the help of the subject teacher. There were two form D classes and the researcher moved from class to class when the post questionnaire was administered. The post questionnaire was conducted in the afternoon and some learners dodged that afternoon class thus withdrawn from the study. This might have been caused by disorganised transport from WASA which resulted in learners walking on feet back to school. Therefore, some students could have been tired and they went straight home while others withdrew.

3.6.3 Learner interviews

After responding to the post questionnaire learners were told that the researcher will come after two days to conduct interviews on ten learners. After two days, the researcher was back at the school for some interviews. She took time to emphasize the purpose of the study to the learners for the second time. Learners were chosen based on the comparison of the pre and post questionnaire responses that showed knowledge gain and were interesting in accordance with the research questions of this study. Ten learners were intended to be interviewed but only eight learners showed up. The two of them did not show up because there was a talent show in the afternoon and were the participants in that show therefore should have been busy preparing themselves. Before the interview learners were reminded that they could withdraw at anytime.

The interviews took about one and half hours with not less than a duration of ten minutes per participant. The interviews were conducted in the science laboratory which was quite and not in use by that time. Note taking and voice recording were done to collect data. The interview questions were semi-structured, and were developed based on the first two questions of the questionnaire as to find in-depth knowledge gained during the visit. Those questions are: (a) Except for farming purpose how is river water important to you? Explain your answer. (b) Some villagers in rural areas collect water from uncovered wells,

but the water is sieved before drinking to make it clear. Is this water safe for drinking? Explain your answer.

3.6.4 Transcription of the interview

The recorded conversation during the interview was played back and transcribed by the researcher (see appendix 4). Before the transcriptions were made the notes taken by the researcher during the interviews were read as to remind the researcher of the information captured during the observations. Allen (2002) supports that being familiar with the display makes the transcriptions more accurate since the participants would be heard on what they say. These notes were also visited when the audio recorder was not clear enough.

3.6.5 Learner observation

Observation data was collected based on what aspects of the visit influence learning at WASA. Denscombe (2007) affirms that in observation, the researcher is an eye witness and data is not attained from what other people say. In the observation, the researcher was a passive participant with no established role to play. Data was collected through note taking and no audio or video recording was used. With field notes there was a written account of what the researcher had seen, heard and experienced in relation to investigated phenomenon (Bogdan & Biklen, 2003).

The observation schedule was developed in consideration of how activities at WASA contribute to learners' knowledge about community health. As previously stated, the researcher observed a group made of twenty learners guided by the tour guide and the researcher was part of the group.

The researcher joined the group of learners that frequently asked the question in the beginning of the tour when water purification steps were explained. This is because the researcher was interested in learners' questions and their interaction with other learners. Learners and educators were observed on what activities they were doing during the visit. The researcher observed this group of students attentively and wrote the field notes. During the tour, the interaction of the learners with others or with the tour guide was recorded and the recordings were done at ten minutes intervals for one hour.

3.6.6 School selection and sample

One Hundred Form D learners were the participants in this study. The selection of students was not random but purposive because participants were expected not to have dealt with community health topic as to identify knowledge gained as the result of the visit to WASA. Therefore the high school was the first priority in this study since community health is the topic done at high school level. Besides that, the school also had to be in town for the convenient organization of transport to WASA in case the follow up visit was required. The selected school in this study was the catholic school located in Maseru, the capital town of Lesotho where the main branch of WASA is located. Learners were at the age of 16-17 years and gender was not of the main importance in this study but girls were more than boys.

3.6.7 WASA overview

As previously stated, WASA is the private company that purifies water. Learners tend to visit this area for demonstration of water purification, sewage treatment and water pollution. School tours operate on Monday to Friday from 10:00 a.m. to 1:00 p.m. and are conducted by trained tour guides. However in this study the tour was conducted by students on internship. Learners observed the seven steps of water treatment, the tour guide explained each step and allowed learners to ask questions. Teaching aids at this place are real. For example chemicals such as chlorine are shown to learners in clarification of the concept under study. In the sewage treatment site learners are shown different stages of sewage treatment until water is discharged into the rivers.

3.7 Procedures in data analysis

Even though a hundred learners were involved in my study only eighty questionnaire responses were analyzed for the following reasons: Some learners participated in pre questionnaires but withdrew from post questionnaires and their responses were rejected. This is because both pre and post questionnaire responses were valuable in detecting knowledge acquired during the visit. Therefore, the pre questionnaire alone would not indicate knowledge gain that result from the visit. The disorganized transport from WASA to school resulted in withdrawal of participants from this study because they had to walk on foot from WASA back to school. Therefore, some learners were so tired that they

dodged the afternoon classes, the time at which post-questionnaire was administered. The eighty learners chosen were those involved in both the pre and post questionnaire. Only data from learners who provided a response for a particular question were analyzed. Blank sheets were omitted thus the number of learners reduced from hundred to eighty.

There are different methods of data analysis but my study used inductive approach of which coding is the major part of data analysis of observations, interviews and questionnaire used in this study. With regard to inductive analysis, explanation of the phenomenon starts from the particular within data to general definition (Hatch, 2002). For this reason the researcher read the field notes, interview transcripts and the questionnaire responses as to formulate categories (Inductive).

Pre and post questionnaire responses were coded according to open ended procedures (Strauss & Corbin, 1990). In this analysis concepts are the major basis of analysis where explanation of phenomenon is given the conceptual label and related concepts may be grouped to form the category. Hatch (2002) states that in inductive analysis the researcher has to look for themes not predetermined. In this study identifiable patterns during the process of analysis using categories designed were used to draw a conclusion when there is a collective relationship amongst each other.

Categories identified from the questionnaire were associated with (a) the use of the river water, (b) whether it is safe drinking uncovered water, (c) importance of pit latrines, (d) importance of boiling untreated water. Similarly, the interview responses for eight learners were coded and categories formulated were similar to the ones used in pre and post questionnaire. The useful emerging trends in this study were considered and categorized as Cohen & Manion (1994) suggest. Consideration of the emerging data has been done through Merriam (1998) advice that emerging data should only be taken into account if they seem to answer the research question.

Here is the sample of the questionnaire and interview responses showing how the categories were formed. Question 1: Except for farming purpose how is water important to you? Explain your answer.

*Learner 1: River water is used for washing and drinking (**Domestic purposes**).*

*Learner 2: River water is used for building houses (**Industrial use**).*

*Learner 3: River water is used for animal drinking (**Other**).*

Two distinct categories in question one were identified and those are river water is used for **domestic purposes** and **industrial use**. The responses not related with those categories were grouped under ‘other’ as shown above.

The interviews questions were developed in relation to the first three questionnaire questions and compared with pre and post questionnaire responses. During coding of the interview responses, categories similar to pre and post questionnaire were identified.

Researcher: from your knowledge where does tap water come from?

*Learner: I think it comes from the rivers and dams. And it is being treated at WASA so that we can drink it without some germs. [**Domestic purpose**].*

Researcher: Do you think boiling untreated water is enough?

Learner: No water has to be sieved first and then boiled to kill bacteria and germs.

Researcher: so you are saying that it is fine to use water from the river as much as it is boiled?

*Learner: Yes, because we have killed the germs and we can drink it. [**Impurities removal**].*

Learners’ response from the first question indicates that river water is used for domestic purposes similar to the category identified from the questionnaire. The second question is about boiling water and the learner indicated that germs are killed when the water is boiled. This is similar to the identified category from the questionnaire that boiling water removes the impurities.

The observation notes were coded and categorised in accordance with the following activities Manipulation, Observing or listening and interaction. The observation schedule indicating the captured activities were interpreted and described. Here is the example of the coded and categorized observation notes.

*Students are grouped near the drawing board that illustrates seven steps involved in water purification. The tour guide explains the steps while learners are listening (**listening**) and others are copying those steps illustrated on the board. Learners ask questions during the explanation of the water purification steps (**interaction**). Chlorination is the last step explained and the tour guide shows the learners the kind of chlorine they use in purifying water and the sample is passed from one learner to the other (**manipulation**). Learners are shown in groups of twenty all steps involved in water purification at WASA (**observation**)learners ask the questions amongst themselves while other ask the tour guide (**Interaction**) during the observations.*

3.9 Ethical considerations

Ethics in research are considered with an intention that no one should be harmed or wronged (Opie, 2004). The researcher applied to human research ethics committee (non-medical) at the University of the Witwatersrand and submitted a detailed research proposal and the clearance letter was given in response (see appendix 17). The participants in my study were learners from one school in Lesotho. The researcher therefore wrote a letter to each learner to participate in the questionnaire (see appendix 5), a letter for learners to participate in interviews (see appendix 10) and their parents (see appendix 6). A letter was also written to the principal (see appendix 7), the subject teacher (see appendix 8), regarding the aim of the study and detailed information about the researcher. The letters were written in a manner that it was easy to understand and clarified that learners' participation is voluntary and could withdraw at any time if they so wish. The consent form had the information sheet regarding the purpose of the study (see appendices 12,13,14,15 and 16).

There was no bribery in invitation of participants and learners were not penalized for not taking part in my study as Opie (2004) explain ethics in research. Additionally, learners were assured that any written or verbal communication will strictly be treated in the confidential manner and their original names were not used in my study. Learners were also informed that their information will be used only for the purpose of the research,

improvement of learning and teaching of science. Finally, a letter of consent accompanied the letter which learners were requested to sign.

The principal of the participating school and the director of education department were also contacted to ask for the permission for students to be involved in my study. With education department, there were no forms to be filled for application therefore a letter was only written to the director of education department (see appendix 11). Similarly, I applied to the director of WASA for permission to conduct my study at WASA (see appendix 9). Opie (2004) argues that the ethics should be applied throughout the research therefore the findings should be presented in the way that no one feels humiliated. Again, the research procedures were designed in a way that participants would not feel frustrated by the time they spent either being interviewed or answering the questionnaire questions. That is the allocated time for participant to answer the questionnaire and interview questions was not long but reasonable. Since the findings from the research are published, the researcher should carry out the study in a way that the findings would not be misleading (Mosabala, 2009). For this reason the given findings are not based on things that do not originate from the collected data.

Conclusion

In this chapter I have explained in detail the methods used in data collection, the sample and the procedures used in data analysis.

Chapter four

Results and discussion

4.1 Introduction

This chapter presents the investigation results of the impact of the visit to WASA on learners' knowledge about community health. Interpretation given to the questionnaire responses, interviews and observations is discussed in some detail. Data analysis has been carried out to answer the following research questions:

- To what extent does form D learners' knowledge change as a result of a visit to WASA?
- What aspects of the visit influence learners' knowledge about community health?

4.2 Results of pre and post questionnaire

Both pre and post questionnaires were made up of the same six open ended questions and the post questionnaire had a seventh question. Eighty learners completed both the pre and post questionnaires and the analysis was based on these eighty learners' responses. The pre and post questionnaire responses were coded, categorized and compared so as to identify knowledge acquired during the visit. Gained knowledge identified from learners' responses is described either as enrichment or conceptual capture. Enrichment and conceptual capture are forms of conceptual change explained by (Chi, 2008 & Vosniadou, 1994) respectively. Enrichment is when new information is added to learners' existing knowledge while in conceptual capture learner's existing ideas are slightly modified. Enrichment may be encountered in instances when learners' existing knowledge is scientifically acceptable but with some missing aspects. Conceptual exchange occurs when there is an in-depth modification of existing ideas that are irreconcilable with new ideas (Hewson, 1981) but is not revealed in this analysis because the researcher did not ask appropriate questions to gauge if conceptual exchange had occurred. The following conditions foster the stated forms of conceptual change and those are: intelligibility, plausibility and fruitfulness of the idea. With intelligibility, a learner accepts the idea because it makes sense but does not relate it to what she already knows. Plausible ideas

are accepted and make sense to the learner for they relate to existing ideas and are used to solve other problems.

With regard to fruitfulness, the concept can be extended and be used to negotiate meaning from other experiences (Posner, Strike, Hewson & Gertzson, 1992). Plausibility initiates enrichment and conceptual capture because the learner makes sense of the new idea that is related to the context of existing ideas (Hewson, 1981). The difference between the two is that the learner only adds the missing information in enrichment but slightly restructures existing ideas in conceptual capture. Conceptual exchange occurs for ideas that are mutually irreconcilable (Hewson, 1981), therefore the new idea has to be fruitful as to replace the existing idea.

Question 1: Except for farming purpose how is river water important to you? Explain your answer.

This question was intended to find out if learners were aware that rivers are the sources of the tap water. For this question learners gave a variety of responses which were categorized into domestic and industrial purposes while ‘other’ is for answers that do not fit in the stated categories such as river water is used for animal drinking.

Table 1: Results of the analysis to question 1

category	Explanation	Pre-questionnaire (n=80)	Post-questionnaire (n=80)
Domestic	It is purified and used for domestic purpose	3	51
	For drinking and washing	29	21
	Cooking and washing for rural people	36	2
	Cooking and washing in water crisis	10	0
Industrial purposes	For building houses and generating electricity	0	6
Other	(For animal drinking)	2	0

The results show that thirty six learners believed that river water is used for domestic purposes only in the rural areas. This is because people in the rural areas get water directly from rivers due to lack of services, while most people in the urban areas have access to purified water drawn from the rivers and dams (Shannon, Paul, Elimelech, Georgiadis, Marinas & Mayes, 2008). The inclusion of the phrase “for rural people” may imply that learners do not associate or link tap water used in urban areas to the river as a source. Consequently, learners might have not considered the fact that rivers are also water sources for people in urban areas though water is accessed from taps. This is in line with McPeak (2009) study that indicates that learners thought that water is a limitless resource that comes automatically from the tap. Before the visit, only three learners stated that river water is purified and used for domestic purpose but after the visit the number increased to fifty one showing that learners now know that the river is the source of tap water. I therefore regard this as a conceptual capture since learners slightly modified their existing knowledge with the new knowledge acquired during the visit. The pre and post questionnaire responses show gain of knowledge.

Question 2: Villagers in rural areas collect water from uncovered wells, but the water is sieved before drinking to make it clear. Is this water safe for drinking. Explain your answer.

The question intended to find out if learners are aware that clear water is not the indicator that water is safe for drinking since there may be invisible impurities harmful to human life.

Scientifically acceptable answers: No because-

- *There may be harmful impurities that are not removed by sieving.*
- *it is not purified*

Table 2: Results of the analysis to question 2

Responses to the first part of the question	Explanation	Pre-questionnaire (n=80)	Post-questionnaire (n=80)
NO	Correct There might be harmful impurities such as germs.	55	41
	Jik has to be added to kill germs	1	0
	It has to be boiled before use	16	17
	It has to follow several steps of water treatment at WASA	0	20
Yes	Incorrect Has no germs because it comes naturally.	5	0
	It is clean and have nutrients.	3	0
	It has chemicals	0	2

Before the visit, fifty five learners stated that sieving water is not enough for it may have harmful germs. This shows that learners’ prior knowledge was in line with accepted knowledge of science. Learners further clarified that bacteria are very small and can pass through the sieve therefore water from uncovered wells is not safe for drinking.

Learner: it is not safe because some impurities can pass through the sieve, again germs also can pass through because they are small.

The learners’ description indicates that learners knew before the visit that clear water is not the indicator of safe drinking water. Sixteen learners in the pre questionnaire response stated that sieving water is not enough and water should be boiled before drinking. The response shows that learners know that boiling is one of the purification methods and removing visible impurities in water does not make water safe for drinking. Five learners mentioned that wells are natural water sources with safe drinking water than tap water however, the statement could be true for covered wells.

During the visit, the tour guide talked about addition of chlorine to kill germs. As a result four learners out of forty one in the post questionnaire contended that sieving water is not enough because germs can pass through the sieve unless chlorine is added to kill germs.

Learner: No because the water has germs and should be boiled or add chlorine as to kill germs

Even though learners already knew that clear water might have germs an additional information is that adding chlorine kills germs. Therefore learners enriched their existing knowledge through addition of the new information (Chi, 1998). One learner stated that sieving water is not enough unless jik is added to kill germs.

Learner: Jik has to be added before that water is drank

Addition of jik to water might be the learner's life experience and is scientifically correct because jik is bleach with chlorine that kills harmful germs (Crump, Okoth, Slutsker, Ogaja, Keswick & Luby, 2004). Some practices at home are scientific but learners may not know the scientific explanation behind those practices. However, during the visit the tour guide stated that boiling and addition of bleach are traditional methods that may be used to treat water in places with no access to treated water from WASA. The explanation about the addition of jik to water might have reinforced learners' existing knowledge since it is a daily life experience as McPeak (2009) states that outdoor learning may reinforce learners' existing knowledge.

In the post questionnaire, seventeen learners stated that sieving water is not enough instead that water has to be boiled to kill germs since the villagers have no access to chlorine.

Learner: No, because the water needs to be boiled in order to kill the unwanted germs because there may be no chlorine at home.

This is correct and suggests that learners have been aware that boiling water serves the same purpose as adding chlorine in water. In the post questionnaire, two learners stated that the water from a well is safe for drinking for it has chemicals. This is an alternative concept that might have been acquired from the visit since the tour guide talked about the

chemicals such as chlorine in water purification. Even though out-door learning offers realism on concepts of interest, learners may interpret the information communicated during the visit wrongly (Lelliot, 2007). When this incorrect information is not cleared through instruction in the science classroom, it may result in misconception thus the need of formal education and post visit discussion activities to supplement outdoor learning revealed. The results further show that most learners (seventy two) before the visit were aware that untreated water is not good for human health even when visible impurities are removed. It is after the visit that twenty learners suggested the use of water purification through several steps demonstrated at WASA. Enrichment in this case is identified since learner's existing knowledge that boiling water kills germs is added with the new knowledge that for large scale purpose, impurities in water are removed at purifying stations such as WASA. The results also show that learners' incorrect ideas were rectified as a result of the visit to WASA because they decreased from eight to two.

Question 3: Is water which has the runoff from agricultural fields safe to drink?

Explain your answer.

The question intended to find out if learners know that the removal of germs in water is not the only attribute that makes water safe for drinking. Therefore, boiling water is not the only effective purification method since odour and pH change cannot be corrected like water purified by companies such as WASA

Scientifically acceptable answers: No because

- *Toxic impurities such as chemicals carried from agricultural fields might have dissolved in that water.*

Table 3: Results of the analysis to question 3

Responses to the first part of the question.	Explanation	Pre-questionnaire (n =80)	Post-questionnaire (n=80)
No	Completely correct		
	It has harmful chemicals	50	46
	It has germs	15	15
	It has to be purified before use.	9	15
	Partially correct		
	it has diseases. (<i>only disease carrying germs are found in water not diseases</i>)	3	2
Yes	Not correct		
	It has minerals for good health	1	0
	It has chemicals that kill germs	0	2
	Purified with chlorine	2	0

Fifty learners specified that water might have chemicals from agricultural fields. This is the correct explanation and implies that learners' prior knowledge may not always be naive (Chi, 2008). Therefore, learners are not empty vessels to be filled with knowledge. However, there are instances that learners find their existing knowledge functional even when not in line with accepted knowledge of science (Ozdemir and Clark, 2007) and conceptual capture fails. The scenario is reflected on two learners who stated in both pre and post questionnaire that the water might have diseases. To say that water has the disease is the language normally used at home (personal experience) and makes the explanation incorrect because 'disease causing germs' are found in water not diseases. Resnick (1983) supports that the individual's language may inhibit the development of other concepts.

Two learners in the pre questionnaire responses stated that the water is safe for drinking because it was purified with chlorine. However, chlorine does not remove dissolved chemicals in water but is used to kill germs at the last step of water treatment before water is supplied to the taps (Shannon, Bohn, Elimelech, Georgiadis, Marin & Mayes,

2008). It was not clear to the learners that purified water can be recontaminated due to poor storage. Similarly if the purified water flows near the agricultural fields, chemicals from the field can recontaminate that water (Gadgil, 1998). Therefore the use of chlorine is not the assurance that germs cannot survive in purified water. Apart from that, two learners stated that water is safe for drinking because it has chemicals that can be removed through boiling. Nevertheless, not all chemicals are removed through boiling since some chemicals have a higher boiling point than water (Bissen & Frimmel, 2003).

In conceptual change, when the learner restructures or revises the existing knowledge to accepted knowledge of science mistakes can happen and result in wrong information (Vosniadou, 1994). This is reflected in two learners that had the perception that water with runoff from the agricultural fields is safe for drinking because it has chemicals that kills germs. This is not scientifically correct because not all chemicals make water good for drinking. During the visit, learners were told that in water purification, chlorine is used at the last step to kill germs. Chlorine is a chemical and being used in water purification does not mean that any chemical can be used to kill germs in production of potable water. Therefore, the two learners misunderstood this part of information communicated during the visit. Even though the pre and post questionnaire show that most learners had the correct ideas about water pollutants, the results also indicate that learners may acquire incorrect ideas from the visit (Lelliott, 2007). However, the post questionnaire shows that reasonable responses were attained as a result of the visit since completely correct responses are seventy four in the pre- questionnaire and seventy six in the post-questionnaire. Learners' responses show conceptual capture since learners rectified their responses after the visit even though the difference is little between the pre and post responses.

Question 4: Pit latrines are encouraged in Lesotho, what do you think is the purpose of this?

The major factors that increase the high risks of water borne diseases are poor sanitation and limited availability of good quality water (Gadgil, 1998). The question was developed

for the researcher to find out if learners can make the link between the quality water and the good sanitation.

Scientifically acceptable answer:

- *To prevent contamination of water by sewage and disease causing germs.*
- *reduce water treatment cost*

Table 4: Results of the analysis to question 4

Category	Explanation	Pre-questionnaire (n=80)	Post-questionnaire (n=80)
Reduction of water pollution.	Correct		
	Prevent water pollution by sewage	35	40
	Reduce water treatment costs	0	9
	Prevent disease carrying germs	30	26
	To minimize the use of flushed toilets	13	2
Safety of water	Incorrect		
	Prevents soil erosion	1	0
	To store rubbish	1	0
	To store manure	0	2

Categories used in the analysis of this question have been created by the researcher and those are: reduction of water pollution effects, prevention of diseases, and to save water. In both pre and post questionnaire, most learners (thirty five and forty respectful) were aware that pit latrines are built to prevent contamination of water by sewage. In the post-questionnaire responses, thirty learners stated that sewage might have disease carrying germs harmful in people's health. The response indicates that learners' prior knowledge was scientifically acceptable. Few learners in the pre questionnaire (thirteen out of eighty) thought that pit latrines are built to minimize toilets that are flushed. This is true but not the main reason for the encouragement of pit latrines in Lesotho since pit latrines are intended to alleviate water borne diseases caused by poor sanitation (Daniels, Cousens, Makoae & Feachem, 1990). It is after the visit that the number of learners with this scanty

knowledge decreased from thirteen to two. This is evidence that conceptual capture occurred since learners opted for knowledge communicated at WASA.

After the visit, nine learners stated that highly contaminated rivers increase water treatment cost at the purifying stations such as WASA. Not only have learners learnt that sewage pollutes river water but gave additional information that polluted water requires more chemicals to purify it. The information communicated during the visit appears to have been fruitful (Posner *et al.*1992) because learners extended knowledge acquired during the visit to answer other question thus conceptual capture revealed. However, there is a little difference between the pre and post responses.

Question 5: Some people have no access to clean water, what is the purpose of them boiling water before use?

This question intended to make learners aware that boiling only kills germs but does not remove some chemicals that might be harmful to human body.

Scientifically acceptable answer:

- *To kill germs and remove chemicals with lower boiling point than that of water.*

Table 5: Results of the analysis to question 5

Category	Explanation	Pre-questionnaire (n=80)	Post-questionnaire (n=80)
Removal of microorganisms	Completely Correct To kill germs	73	77
	Incorrect To kill diseases	1	0
Removal of 'some' chemicals	Partially correct Remove chemicals (not all chemicals are removed during boiling)	4	3
	Incorrect To kill chemicals	2	0

The results show that learners are more familiar with germs as water pollutants that are killed through boiling. In the pre questionnaire, seventy three learners stated that boiling kills germs. This is learners' prior knowledge and is in line with accepted knowledge of science. Four learners stated that water might have chemicals, therefore boiling removes chemicals. Even though, learners are right to say that water might have chemicals, not all chemicals are removed during boiling thus the response categorized as partially correct. Chemicals removed during boiling are likely to have a lower boiling point than water while chemicals such as arsenic and heavy metals cannot be removed (Bissen and Frimmel, 2003). It is therefore not completely right to generalize that all chemicals are removed during boiling and the main purpose of boiling water is to kill germs.

In the pre-questionnaire responses, one learner stated that boiling kills diseases while the two said chemicals are killed. These two explanations are not scientifically correct since chemicals and diseases are not killed but disease carrying germs are the ones killed during boiling. Language used at home (community code) is different from language used at school (school code) and learners with community code are easily challenged by school code (Taylor, Muller & Vinjevoid, 2003). Learners might have understood the scientific explanation but the language used at home contributes in poor expression of scientific concepts. The results however show knowledge gain through conceptual capture in which learners' responses are rectified.

Question 6: Can water that has been treated by sewage plant be used for domestic work (eg. preparing food)? Explain your answer.

The question intended to find out if learners know that even water from the sewage plant can be purified and be used for domestic purposes.

Acceptable answer: Yes because

- *Sewage is treated and discharged into streams or rivers and purified before use.*

Table 6: Results of the analysis to question 6

Main category	Reason	Pre-questionnaire (n=80)	Post-questionnaire (n=80)
Yes	Completely correct It is purified at WASA before use.	0	61
	Boiled before use	35	0
	Partially correct It should 'only' be used for irrigation (the missing aspect is that it can also be purified and be used for domestic purposes).	11	2
No	Incorrect It is not hygienic	34	17

Thirty five learners in the pre questionnaire response were aware that water from sewage treatment can be reused. Some learners in the pre-questionnaire stated that the water can only be used for washing and irrigation because it is not clean. The response is not completely correct because of the word 'only' since that water could be discharged into streams, purified and be used for domestic purposes. The word 'only' in the response could mean that the treated water from the sewage plant is not suitable for consumption therefore could do other tasks other than cooking and drinking. However, in the post questionnaire results the stated response decreased from eleven to two and this shows the conceptual capture. In the pre-questionnaire responses, thirty four learners stated that the water is not good to be used because it is not hygienic. It is after the visit that most learners were aware that sewage plant treats water and this water is discharged to streams and purified for daily life purposes.

Sixteen learners out of thirty five in the pre-questionnaire responses stated that there are some possibilities that germs cannot all be killed when the water is purified therefore that water has to be boiled before drinking. There are several steps involved in water purification steps and the chlorine added in the last step kills germs but the learners seem to doubt the use of chlorine on sewage treated water. The tour guide at WASA encouraged

learners to boil the purified water before use and keep it covered. This might have given learners a suggestion that water purification steps at WASA may sometimes fail to kill germs. However, the encouragement was made to avoid health risks that might be caused by the recontamination of water (Gadgil, 1998). The post questionnaire results show that learners' knowledge changed as a result of the visit to WASA.

Seventeen learners in the post-questionnaire responses still believed that water from sewage plant cannot be reused because sewage is harmful to people's lives. Learners might have accepted that sewage is treated but did not believe that the same treated water could be purified and used again for domestic purposes. It therefore suggests that learners found the information about sewage treatment intelligible as it did not reconcile with their existing idea that sewage has disease carrying germs. In this case, conceptual capture has not occurred since learners did not admit that water from sewage treatment could be reused. It is scientifically correct to say that sewage is harmful but the idea hindered the knowledge acquisition about sewage treatment. It therefore entails that not only misconception hinder science learning but even the correct concepts when isolated may hinder acquisition of science knowledge. If learners incorporated the idea of chlorine use in water treatment it would be easier to understand that water treated by sewage plant could be treated and used for domestic purposes. The comparison of the pre and post questionnaire results show that learners attained knowledge as a result of the visit to WASA.

4.3 Interview Analysis

In this study, the interviews were conducted to detect if there is knowledge gain from learners' responses. Eight learners were interviewed and criterion used in selection of those eight learners was through comparison of pre and post questionnaire responses. For this reason, learners with unanswered questions were ignored. Learners who changed their responses in the post questionnaire were chosen (see section 3.6.3). Interviews were conducted because learners might not have expressed themselves precisely through writing thus probed further. Similar to section 4.2, gained knowledge was described either as enrichment or as conceptual capture.

The following keys will be used in this section.

- ITQ- interview question
- L- learner

Eight learners with the responses of interest were chosen and their responses compared with pre and post questionnaire. The responses were also described as either enrichment or conceptual change. The results are presented as follows: the learner’s pre and post questionnaire response then the interview and discussion.

Question 1: Except for farming purposes how is river water important to you?

Table 7: Learners’ Responses to question 1

Learners	Pre-questionnaire	Post questionnaire
L 1	For domestic purpose during water crisis.	It is treated and used for domestic purpose
L2	For washing and drinking by people at the rural area.	Washing to save tap water
L3	For washing	For cooking and drinking when treated
L4	For washing	For drinking and washing
L5	For washing at the rural areas	Supplied to people after treatment at WASA
L6	Useful at the rural areas for washing	For Washing
L7	For washing the blankets	For drinking after being purified
L8	For washing	Washing and drinking when cleaned at WASA.

Learner 1

Learner’s response prior to the visit proposed that the river water is used during scarcity of water. However, in the post-questionnaire the learner opted for the information communicated during the visit. It is likely that new knowledge communicated at WASA related to learners’ existing knowledge thus conceptual capture attained (Hewson, 1981). Rivers as previously mentioned supply people in Maseru with water after being treated at WASA. The learners’ pre-questionnaire response does not connect river water with any form of water treatment. The excerpt below gives additional evidence that it is after the

visit that the learner knew that rivers are the main sources of the water that comes out through taps.

ITQ: From your knowledge where does tap water come from?

L: I think it comes from the river and dams. And they are being treated at WASA so that we can drink them without germs.

ITQ: Where did you first think tap water is coming from?

L: I thought it was just coming from the tap at WASA, they build the dams and when the rain is raining it gets water and passes to our taps.

The response indicates that the learner knew before the visit that tap water comes from WASA but was not familiar with the purification steps involved during the process. The learners' existing idea is correct that the dams are built at WASA however, those dams not only collect rain but are meant to collect water from the rivers to be purified and supplied to water taps.

Through the visit to the site where river water is drawn for treatment at WASA, the learner found that the new ideas communicated at WASA were true and similar to existing ideas and this resulted in conceptual capture (Banet & Ayuso, 2000). Similar to Piaget's (1964) assertion, the new information makes sense to the learner when related to existing ideas. Hewson and Hewson (1984) add that learning occurs when the unknown is related with the known.

Learner 2

The interview excerpt below shows that the learner knows that the river is the water source and it is costly and time consuming to purify river water therefore, water has to be used wisely.

T: From your knowledge where does tap water come from?

S: It comes from WASA and they said their source is Mohokare (one river in Lesotho)

ITQ: what can you say about the wise use of water?

L: People have to conserve water as people at WASA said if the water used is exceeding the one estimated, they have to pay for that water. Similarly people will have to pay a lot of money and will resort to untreated river water which is not good for their health. Chemicals used are also expensive while several steps followed during the process are so many therefore water should be saved.

Learners' idea on the post questionnaire of using untreated water to save tap water might have been influenced by the knowledge gained from WASA that costly chemicals are used in water purification, therefore the exploitation of water may increase the cost at WASA. Besides, the visit to WASA seemed to have been fruitful because initially the learner knew the river water as only useful for people in the rural areas. However, the response after the visit showed that the learner realised that rivers are not only beneficial for rural people but should also be used by people with access to clean water in an attempt to save tap water. Several steps followed during water purification may have initiated learner's concern that water has to be used wisely and be saved.

Not only did this learner acquired information about water purification but realised that the overuse of water may increase the charges for everyone using tap water. The visit to WASA seemed to have made learners aware of the economical issues caused by overuse of water. It further suggests that with knowledge attained from out-of-school context, learners may be able to contribute to environmental debate as outlined in Henriksen & Jorde (2000). It is through the conceptual capture that learner's existing ideas changed to accepted knowledge of science as the excerpt below shows that the learner already knew that tap water comes from WASA though had not been familiar with several steps involved in water purification.

ITQ: Now that you know that water does not come automatically from the tap, but did you know that before ? where did you think we get tap water from ?

L: I thought there was this big pipe connected to the river and some big tanks where there would be pipes splitting to the taps, not knowing that there are so many steps followed before water is distributed.

Learner 3

The learner's initial response indicates that river water is used for washing. However, it is after the visit that the learner specified that river water could be used for cooking and

drinking when treated. Due to scarcity of water, especially in rural areas of Lesotho, most people rely on river water or wetlands (Bharwani, Shale, Taylor, Matin, & Downing, 2007).

Therefore, the pre-questionnaire response might be due to learners' daily life experience as Resnick (1983) states that the intellectual environment such as practices and cultural beliefs of individuals play the crucial part in development of concepts. However, in the post questionnaire the learner added the new information as a result of the visit that river water is treated and used for drinking and cooking. In contrast, the learner in the interview states that borehole is the water source while rivers 'sometimes' serve as water sources.

ITQ: From your knowledge where does tap water come from?

L: Sometimes we collect that water from the river because we do not like water in one place like in dams and what I am trying to say is water in dams is not clean. During summer time where there is no rain that is where we collect it from, but most of the time we collect it from the river.

ITQ: Are you saying that this water that we get from the tap is from the river?

L: Sometimes, but we get water underground, bore hole.

The learner insists that bore hole is also one of the water sources. The idea about borehole might be because of learner's experience at home as water is drawn from the borehole in some homes. For this reason, the learner considers water purification as not the only way to get potable water. Even though learner's idea is right, borehole water may be contaminated and cause water borne diseases such as diarrhoea (Willocks, Crampin, Milne, Seng, Susman, Gair, Mouldsdale, Shafi, Wall, Wiggins & Lightfoot, 1998). The notion reveals that learners can connect outdoor visits with their own life experience and prior knowledge (Bamberger & Tal, 2006). However, the prior knowledge may not be in line with accepted science knowledge but the learner may find that knowledge functional to them and feel no need to change what is already known (Ozdemir & Clark, 2007).

The learners' response shows enrichment of existing idea since the learner knew that borehole water is not the only way of getting safe drinking water.

Learner 4

Initially, the learner stated that river water is used for washing and in the post questionnaire stated that the water is used from drinking and washing but has not been clear if it is used untreated or purified. However, the learner knew that WASA collects water from the rivers and dams even though the learner did not know about several steps of water purification.

ITQ: From your knowledge where does tap water come from?

L: From WASA

ITQ: Where does WASA get this water from?

L: Maqalika, 'Muela (Dams in Lesotho) and Mohokare (The river between Lesotho and South Africa).

ITQ: So you can say that water from the taps come from rivers and dams.

did you know that before the visit to WASA?

L: Yes I did, but did not know that there are many steps undergone in water purification.

Learners' prior knowledge in line with accepted knowledge of science might have fostered the acquisition of new knowledge. The tour guide at WASA stated that river water is collected from Mohokare and dams such as Maqalika. The learner remembered the water sources because of the existing knowledge relevant to the new knowledge. In this case, there is no conflict between what the learner already knew and was communicated during the visit. Therefore, the learner acquired the new information through addition of the missing concepts (Vosniadou, 1994). Initially, the learner did not know about several steps involved in water purification but as a result of the visit to WASA, the learner got to know that the water from dams and rivers undergo several steps of purification before it is supplied to the taps. Enrichment is the form of conceptual change that occurred in this scenario because there are no changes made, instead the missing information was added.

Learner 5

Initially the learner stated that river water is useful for washing in rural areas. It therefore suggests that the learner might not have considered that there is a link between rivers and water from taps. It is after the visit that the learner clarified that river water is not only used for washing at the rural areas but is also the main water source for everyone. The excerpt below reveals that the learner did not know before the visit that tap water is from the river. This is similar to McPeak's (2009) finding that learners were not aware that water has to undergo several steps of water purification.

ITQ: Where did you think tap water comes from before going to WASA?

L: I just knew that river water is used for washing and animal drinking in the rural areas, not to be used by people in the urban areas.

ITQ: What do you know now as a result of the visit to WASA?

L: That tap water comes from the river and is purified at WASA.

The learner seems to have acquired the information at WASA through conceptual capture since the whole idea of rivers being used only in the rural areas was modified and stated that river water is treated and supplied to people. Taking learners to outdoor visits is a learning tool that may assist learners to make the crucial connection of their surroundings to their everyday lives (Riskowski *et al.* 2009). Therefore, knowledge gained at WASA may assist learners to be conscious environmental citizens and encourage learners to make wise decisions regarding use of water.

Learner 6

Similar to learner five, learner six states that river water is important for people in rural areas for washing. There is no connection of river water with any form of water purification in both responses. However, the excerpt below indicates that the learner knew after the visit that rivers and dams are water sources.

ITQ: Where does tap water come from?

L: Caldon river and mohokare and sometimes from Muela.

ITQ: did you know that before?

L: No.

When looking at the questionnaire response the slight modification is done but does not incorporate knowledge communicated at WASA thus interviews important to expose what one knows. The learner acquired knowledge at WASA hence conceptual capture occurred. The learner could also remember the names of the river and has known the main water sources.

Learner 7

Initially the learner stated that river water could be used for washing the blankets. This could possibly be a daily life practice in places near the river even when there is tap water, as to avoid the high water bills. Therefore, the learner might have known that tap water is paid for, though not familiar with the main water sources. However, the learner in the post questionnaire response linked the river with the idea of water purification, showing that it is a result of the visit that the learner knows that river water is purified and used for domestic purpose, therefore cannot only be used for washing clothes. This is a knowledge gain in the enrichment manner of which the learner attained the new information that river water could be purified for domestic use.

ITQ: From your knowledge where does tap water come from?

L: It comes from dams and rivers, Eh ... as it is pulled by the machinery to WASA.

The actual observation of the river water being drawn from the river to WASA might have provided the evidence to the learner that river water is the water source. As a result, the learner reorganised the existing knowledge through conceptual capture as the existing knowledge was reorganised to accepted science knowledge.

Not only has the learner learnt that rivers are water sources but realized that there are several steps involved in water purification before water is supplied to households.

ITQ: Is there any importance of visiting WASA?

L: Yes, because I have learnt that water moves through many stages where it was purified.

Similar to learner seven, some learners might not have known before the visit to WASA that there are several steps involved in water treatment purification process. The fact that the learner has known that water purification is not a minute-made activity may make learners conscious of the need for the wise use of water. It therefore shows that the learner might have had the general knowledge that WASA supplies water to the taps but did not know in details the processes followed in water treatment. Therefore outdoor learning not only exposes learners to the new experiences but may reinforce learners' existing knowledge and conceptualisation of abstract concepts (Eaton, 2000).

Learner 8

Learner's prior knowledge is correct that river water could be used for washing. However, that is not the only substantial purpose served by the river water. In the post questionnaire, the learners clarified that river water is purified and used for washing and drinking.

The interview excerpt below further clarifies that the learner opted for the information acquired during the visit that water has to be cleaned before use.

ITQ: where does tap water come from?

L: From my knowledge I think tap water comes from the river. There are the machinery used to deliver water from the river but before that in order for water to be in the tap, the water has to be clean to make sure that there are no bacteria for people not to be harmed by that water.

The learner acquired knowledge through addition of the missing information that river water is used for washing and drinking when purified. The initial response might have resulted from the learner's daily life experiences as Chi (2008) asserts that learner's prior knowledge may be influenced by daily life issues. What the learner knew about the rivers prior to the visit and the additional information attained during the visit reconciled therefore, enrichment seemed to have occurred.

Question 2: Pit latrines are encouraged in Lesotho, what do you think is the purpose of this?

Table 8: Learners’ responses to question two.

Learners	Pre-questionnaire	Post questionnaire
L1	To prevent environmental pollution	To stop water pollution.
L2	To prevent water pollution	To prevent contamination of water by faeces.
L3	To store collected rubbish	To prevent water pollution by sewage
L4	Prevent the spread of disease.	Prevent contamination of water by faeces
L5	Prevents soil erosion during heavy rains.	Collects sewage important for making manure.
L6	To prevent environmental pollution	As a safety area for manure
L7	To collect sewage	To prevent contamination of water by faeces.
L8	To prevent contamination of water by faeces.	Sewage can be washed into the rivers and cause diseases.

Learner 1

The pre and post responses are correct. However, post questionnaire response is more specific. Environmental pollution is a big concept in science syllabus for it includes air, land and water pollution. Therefore, after the visit the learner stated the importance of pit latrines within the context of water pollution. The specified idea might have been opted for as a result of the information communicated during the visit to WASA. Surprisingly, in the interviews the learner referred back to the environmental pollution as stated in the pre-questionnaire response.

ITQ: The government encourages the use of pit latrines, what do you think is the reason behind this?

L: If not used, the environment will smell and discourage tourists to come to our place?

The learner seems to have focused on one common aspect of the effect of pitlatrine use, however shows that not only does sewage pollutes river water may also discourage tourists as explained in the excerpt above.

Through probing, the learner stated that polluted river water may increase the demand of chemicals such as chlorine when water is treated. In this way, not only does the learner know that chlorine is used in water purification, but extended the acquired knowledge further that the more the water is polluted the more chlorine is required. This entails that water pollution is not only harmful to the people using untreated river water but also increases the water purification cost at WASA. Being able to extend knowledge acquired during the visit indicates that the learner found the new knowledge fruitful (Hewson, 1981).

ITQ: with respect to the water that we drink what can you say is the importance of pit latrines?

L: When pit latrines are not built water can be contaminated by faeces and will need a lot of chemicals to be treated such as chlorine gas.

Learner 2

The responses in both pre and post questionnaire indicates that learners' prior knowledge was in line with accepted knowledge of science. In the pre questionnaire, the learner states that the building of pit latrines prevents water pollution but the learner is more specific in the post questionnaire and explains that pit latrines prevent contamination of water by faeces. It therefore suggests that the visit to WASA may influence the precise explanation of concepts. The student further clarified that some people may not be aware of how harmful polluted water is in their lives. For this reason, the use of pit latrines minimizes the health hazards for people who depend on untreated river water. The learner enriched the existing knowledge.

ITQ: So now that you know about the water sources what can you say about the importance of pit latrines?

L: Yes I think there is, because if there were not any pit latrines people will help themselves everywhere. And the village near by the rivers could help themselves and without knowledge can even do it in the river. And water will be contaminated with bacteria and other people wash children's things and drink the water and will make a lot of harm.

The word 'help' on the excerpt above is commonly used in Sesotho language meaning to defecate. Not all of the areas in Maseru have access to purified water, therefore untreated

river water is an alternative for people in those areas. The learner is therefore aware that pit latrines play a vital role in prevention of water borne diseases that might be carried in sewage. Pit latrines prevent the spread of diseases especially to people who might not know the impact of sewage in river water they use. The learner seemed to have appreciated the building of pit latrines with the accepted knowledge of science that good sanitation minimises the risks water disease infection. In this notion, it becomes evident that out-of-school setting may enrich learners' prior knowledge in line with accepted knowledge of science thus knowledge acquisition enhanced. This is similar to DeWitt and Storcksdieck (2008) finding that learner's prior knowledge is the crucial determinant factor on what is cognitively acquired.

Learner 3

The pre-questionnaire response indicates that the learner does not connect the building of pit latrines to water sources as expected. Instead the learner understands that pit latrines store the collected rubbish and does not specifically indicate that it is for collection of sewage. It is after the visit that the learner indicated that pit latrines prevent contamination of water by sewage. The existing idea in this case has been replaced by accepted science knowledge as a result of the visit to WASA and that is called conceptual capture. The excerpt below shows that the learner understood that water pollution has the bad effect on people using untreated water however, had not captured the fact that the purification process becomes expensive when water is highly polluted.

ITQ: Now that you know about the water sources being the dams, do you see any importance of the government encouraging people to build the toilet.

L: Absolutely, especially in rural areas because people there use dongas where the water passes by and that is called the pollution.

ITQ: So how do you think pollution affects people at WASA?

L: Now I am talking about in rural areas, but in here those people in WASA collect water not clean to purify it but in rural areas you will find that those people drink that water as it is

ITQ: this water pollution is still a concern in urban areas, why is it a concern yet WASA treats water.

L: May be to prevent air and water pollution.

The learner might have found the information communicated at WASA intelligible and clarified that river water is purified as it moves. In this way, the learner regarded water purification unnecessary since bacteria in river water are removed as the river flows.

The learner accepted the importance of water treatment at WASA, but believes that untreated river water is also good to be used for domestic purposes since bacteria are trapped. It is true that soil and rock layers naturally filter the ground water to a high degree of clarity but does not make it safe for drinking since harmful chemicals from agricultural practices can contaminate ground water (Bouwer, 2000). The learner might have seen people surviving through the use of untreated water not knowing that pesticides or chemical used in agriculture can possible lead to critical health conditions.

Besides that, naturally occurring pollutants are geological and occur at certain places (Das et al, 1996). Therefore, ground water cannot be regarded as completely clean while river water is definitely not clean because it is exposed to different types of pollutants. However, the learner at last accepted that river water is not pure thus water purification steps valuable in cleaning that water. The learner accepted the new information because of the plausibility of purification steps at WASA and this reveals conceptual capture.

Learner 4

From the table above both pre and post questionnaire responses are in line with accepted knowledge of science since sewage has disease causing germs that may be carried to rivers and harm people using that water. However during probing, the learner no longer linked the building of pit latrines to water pollution but linked that to the atmosphere. This scenario is explained by Dzama & Osborne (1999) that learners resort to their own conceptions when they can't remember scientific concepts.

ITQ: What do you think is the disadvantage of using forests and dams as places for sewage disposal?

L: It is bad because people use water from the river for drinking and cooking.

ITQ: let's talk about these people in the urban areas of Maseru. Let us say WASA supply them with water and therefore don't depend on untreated water. Why do you think it is still the concern of people to build pit latrines at this area?

L: The pit latrines I think are recommended because if we don't use them it is clear we are going to use the forests and we are going to produce the bad smell that will be harmful to the atmosphere.

It is true that there will be a bad smell in the atmosphere due to exposed faeces but the main idea in this question is to state that exposed sewage may be carried to the rivers and contaminate water. The cost for water purification increases with the increasing water pollution. Enrichment is the form of conceptual change that occurred in this scenario and new knowledge communicated during the visit was added on learners' existing ideas. Therefore, only the missing information was added and the existing idea not changed.

Learner 5

The two ideas the learner stated in pre and post questionnaire are not in line with accepted knowledge of science since pit latrines prevent environmental pollution. Learner's idea about prevention of soil erosion changed to the other idea of making manure and are both not aligned with the information communicated during the visit. This indicates that the learner has several alternative conceptions about the importance of pit latrines. The visit to WASA seemed not to have assisted the learner in changing his existing ideas as the excerpt below indicates.

ITQ: What can you say is the importance of pit latrines with regard to mentioned water sources?

L: I can say pit latrines are important because it collects urine and sewage used at the fields as manure.

During the interview, the learner embraced the fact that pit latrines collect sewage used as manure. Conceptual change has not occurred in this case since the incorrect idea is not withdrawn. Knowledge creation is influenced by the worldview one holds (Keane, 2008) and this knowledge is used to solve daily life problems. May be the learner experienced the situation where sewage is extracted from the pit latrines and used in the fields as manure. However, that is not the main purpose of building pit latrines in Lesotho.

Learner 6

The learner indicates that pit latrines prevent the environmental pollution by sewage which is the accepted knowledge of science. However, after the visit the learner stated that pit latrines can be the safety area for manure. Even though the post questionnaire response is not in line with the scientific purpose of pit latrines the learner seemed not to have understood the importance of pit latrines in connection with water quality. The excerpt below shows that the learner believes that pit latrines cause water pollution. Even though the learner's response is not clear, the idea of chlorine seemed to be remembered and shows that the learner gained knowledge.

L: The water will go into the pit latrines and go to the river and when at home collecting the water there will be no chemicals to clean the water and that will be dangerous.

The learner opted for the explanation communicated at WASA that chemicals are used to clean water and does no longer talk about boiling water. This indicates that enrichment has occurred since the learner does not only know boiling water as the only way of purifying water.

Learner 7

Before the visit to WASA, the learner knew that pit latrines collect sewage but did not link their purpose to water sources. It is after the visit that the learner stated that pit latrines prevent water pollution by faeces. Even though the learner could not use the scientific word 'water pollution' it is understood from the excerpt below that the response says pit latrines prevent pollution leading to spread of diseases.

ITQ: Now that you know about the water sources what can you say about the importance of pit latrines, for instance the government encourages people to build the pit latrines can you connect that encouragement from the government with water sources.

L: The importance is that the water or the sewage is stored in the same place is not all around.

ITQ: Ok, why should it be kept at one place not all around?

L: I think because, if the sewage move all around it is not the good thing , that's why we need the pit latrine in order to store that because it can spread disease, when the sewage is carried in the rivers and some people use that water untreated.

There are some people with no access to clean water in developing countries and Lesotho is not an exception. Therefore, the learner explains that the building of pit latrines minimizes the spread of diseases. In this case, enrichment has occurred.

Learner 8

Learner's initial response is correct but more detailed on post questionnaire response. In this scenario, enrichment occurred since the learners' initial response was in line with accepted knowledge of science. Some learners' responses were correct on the questionnaire question but changed when interviewed. This learner is an exception and shows the conceptual understanding of what she is saying.

ITQ: Now that you know about our water sources what can you say about the importance of pit latrine, can you connect why Lesotho is encouraging people to build pit latrines.

L: Oh, I think is because some people may defecate in the river so that is why pit latrines are encouraged in Lesotho so that the water cannot be dirty with faeces that may cause diseases.

The learner went to the visit with the correct explanation of importance of pit latrines in Lesotho and has been easy for the learner to add more information that faeces washed in river water may cause diseases. This is enrichment and conforms to Vosniadou (1994) assertion that enrichment is the simplest form of conceptual change. The simplicity of enrichment is attained due to the fact that there are no modifications made in which mistakes can occur when the response is restructured.

Post questionnaire question 7: could you describe two things you learned from the visit to WASA about Water treatment.

The seventh post questionnaire question intended to investigate knowledge acquired by learners during the visit to WASA.

Table 9: Results of the analysis of question 7.

Main category	Post-questionnaire (80)
WASA purifies water	25
Chemicals are used in water treatment	51
Other	4

Fifty one learners out of eighty learners were able to remember that chemicals are used in water treatment and among those chemicals, chlorine is used at the last step to kill germs.

Learner: I learned that water can be treated by using some chemicals and I also learned that the water can be treated by using steps such as filtering while chlorine is the last step.

This is the correct information communicated at WASA and implies that learners have acquired knowledge about water purification. This is similar to Lelliott (2007) where some learners were able to remember the factual information communicated during the visit. As a result of the visit to WASA seventy six students knew that chemicals are used in water treatment and there are several steps followed during that process.

L1: chlorine gas is added to kill germs.

L2: there are several steps used in water treatment and chlorination is the last step.

This is a large improvement from three of the students who associated river water with water purification prior to the visit to WASA. McPeak's (2009) findings showed the same results in which learners' knowledge about water treatment improved after the visit to the local waste water treatment plant. Some students knew that tap water is supplied by WASA but did not know about the several steps involved in water purification and the river as the water source. However, there were four students who might not have acquired clearly the information communicated at WASA for they stated wrong information. Therefore, their responses have been categorized as 'other'.

L1: I learned that water is added with chlorophyll to kill the germs in it.

L2: Chlorination is the process in which lime is added.

L3: Chlorination gas is added to remove bad taste and odours from raw water

L4: Pre chlorination is the chemical used to clean water.

Some learners stated the correct terms for steps involved in water purification but the definitions were wrong. Chi (2008) states that some naive knowledge can sometimes be revised through instruction in the classroom. Similarly, this wrong information acquired during the visit might be cleared off through the instruction in the classroom as Lelliott (2007) shows that held misconceptions can be unaltered or be reinforced during the visit. However, I regard this incorrect explanation to have been acquired during the visit since the learners did not know about the terminology used in water purification steps before the visit.

4.3 The observation results

The observations were done to answer the second question that says:

- What aspects of the visit influence learners' knowledge about community health?

The observation schedule below has been designed to capture the aspects of the visit to WASA that influence learners' knowledge about community health. The recordings were done at ten minute intervals. Twenty learners were observed as previously explained in chapter three section 3.4.3 and the observation schedule below was used to record the stated activities. As explained in chapter 3 section 3.4.3, manipulation looked at on-task behaviour that includes manipulating or touching of objects, while observing or listening considered any non interactive behaviour that included just looking at the steps involved in water purification or passive listening. Lastly, verbal interaction looked at the talk between at least two people that include asking questions, explaining, making comments about the on-task behaviour (Cox-Petersen *et al*, 2003). The verbal interaction observed in this study was between the tour guide and the learners (tour guide + learners) and amongst learners themselves (learners + learners).

Table 10: Results of the observation of learners as they toured the WASA plant

Time (five minutes is were between the intervals for movement of learners from one place to another)	Verbal interaction Learner + tour guide	manipulation	Observation	verbal interaction Learner + Learner
11:00-11:10	Al, Al, E,		Lo, Li	W
11:15-11:25	Al, At, E, E		Lo,	Al, Al, Al, E, E,
11:30-11:40	Al, Al, C		Li, Lo	Al, E,E
11:45-11:55	E, Al, Al,		Li, Lo	Al, C, E, E, R
12:00-12:10	E, Al, Al, Al, C	T	Lo	R, E, C,
12:15-12:25	Al, C		Li, Lo	Al, E,
12:30-12:40	Al, Al, Al, C,E		Li, Lo	Al, C, E, R

Lo-Looking at what is demonstrated, *Li*- listening passively, *A*-Asking questions (*Al*-questions by the learner, *At*-questions by the tour guide), *E*- Explaining, *C*- commenting, *T*- touching objects. *W*- Notes writing. *R*: Notes reading (the letter was written each time the activity was captured).

For the first ten minutes, learners were grouped near the board that demonstrated seven steps involved in water purification. The tour guide explained those steps and learners looked at the chart, wrote notes and listened. The display oriented learners and acted as the advance organizer and the written notes were used later when purification steps were observed. The display was colourful and attracted learners' attention to look at the drawing as the tour guide explained. The information on this chart was brief and clear, explaining the purification steps drawn on the chart. Learners were given a chance to ask questions and the tour guide answered them. The information displayed on the chart enriched learners' knowledge about water purification at WASA prior to the tour. Similar to Griffin (1998), the visual display at WASA fostered knowledge acquisition about water purification steps as the post-questionnaire excerpt below shows.

Learner: water can be purified using the steps such as filtering and coagulation.

With an over view of the several steps involved in water treatment at WASA, learners were oriented in terms of the purpose of the visit and asked questions in relation to their written notes. Learners might have acquired the information communicated at WASA due to the fact that the orientation helped them to know the purpose of the visit thus meaningful learning attained (Mosabala, 2009). Therefore advance organizer contributed in knowledge gain (Griffin, 1998) about water purification steps as learners used their notes when the steps of water treatment were explained.

In the second interval, learners were divided into five groups with twenty learners per group. Learners looked at the first and the second steps of water purification as the tour guide explained and learners looked and wrote notes on what they saw. In the first step, the water is drawn from the river and poured in the receiving tank at WASA. In the second step, chemicals such as lime are added to water for the particles to coagulate. Learners knew that water from the river is first poured in the tank for other processes of water treatment to follow. It therefore, shows that physical facilities play a vital role in demonstration of 'big' science (Brand & Reiss, 2006) thus contribute in learning in out-of-school-setting (Griffin, 1998). Learners asked the tour guide some questions while some learners asked questions amongst each other. It was at this point when learners' participation was realized in which more knowledgeable learners assisted other learners with little knowledge. The scenario indicated participation as learners shared the ideas and assisted other learners who might not have understood the explanation offered by the tour guide. It therefore suggests that participation is one of the factors that promote outdoor learning (Griffin, 1998).

In the third interval, the tour guide asked learners one question and learners explained looking at the third and the fourth steps of water purification. The third step is called flocculation in which there is a slow movement of water for clumps of floc to form in water while the fourth step is called sedimentation in which the flow of water is greatly reduced and the clumps of floc settle at the bottom forming sludge. The actual observation of water treatment steps at WASA is a visual experience that adds the realism on scientific concepts. Therefore, learners might have remembered the information communicated during the visit because of what they had seen.

Learner: People have to conserve water as people at WASA said if the water used is exceeding the one estimated, they have to pay for that water. Similarly people will have to pay a lot of money and will resort to untreated river water which is not good for their health. Chemicals used are also expensive while several steps followed during the process are so many therefore water should be saved.

Learners also listened to the tour guide and made comments in relation to what they saw. Some learners asked questions to other learners and knowledgeable learners answered.

Learner: is sedimentation the same as 'qitisa'? (Qitisa is the Sesotho language meaning the settling of substances at the bottom of a container with liquid).

This verbal interaction also showed participation (Vygotsky, 1978) in which the tour guide facilitated learning.

For the fourth interval, learners listened passively looking at the fifth and the sixth steps of water purification as the tour guide explained those steps. The fifth step is called carbonation in which carbon dioxide is added to correct the pH of water, while the sixth step is called filtration in which water is filtered and the suspended matter removed. Later, learners asked questions amongst themselves and commented on what they saw.

Learner 1: What did the tour guide say is the accepted pH for safe drinking water?

Learner 2: It is therefore with filtration that visible pollutants are removed.

It was through learners' comments that the researcher realized that learners valued the purification steps at WASA. Learners were also aware that boiling is not the most effective method of purifying water since only germs are removed during boiling while pH and taste are not considered. The scenario also embraced the input of physical facilities in outdoor visits since learners were able to make their own judgments in relation to what they previously knew and the new knowledge communicated during the visit.

In the fifth interval learners asked questions on the last step of water purification and chlorine used in the last step of water treatment (chlorination) was shown to the learners and passed from one learner to another. Holding of chlorine has been categorized under manipulation and has been a congruent experience at WASA that might have assisted learners to remember that not only boiling kills germs but addition of chlorine to water

kills germs. In the sixth interval, learners were taken to the river and shown the machinery that is used to draw water from the river to WASA. It is at this time that learners' comments were heard that indicated that learners did not know that the river was the source of the tap water.

Learner: Oh! We really drink water from the river!

Learners looked and listened to the tour guide explanations and later discussed amongst themselves. The physical facilities as stated earlier contribute in learning in out-of-school context (Griffin, 1998) as learners realized that it is an actual fact rivers are water sources. Additionally, with physical activities at WASA the explanation offered by the science text books that water is reused and rivers are water sources become realistic. Taking learners to the river that supplies WASA with water made learners aware that indeed water comes from the rivers, treated and supplied to the taps. Moreover, the physical activities enhanced learners' knowledge about water treatment.

In the last ten minutes, learners moved to the sewage treatment in which the tour guide briefly described the first and the last stages of sewage treatment. Due to the time constraints, learners were not able to look at the second stage of water treatment but looked at the primary stage and the tertiary stage. In the primary stage, the light suspended solids that might have been left during screening (removal of large solids) are removed. The second stage is activated sludge in which microbes are added in water to remove pollutants. In the third stage, waste water is treated and made suitable to be discharged to streams or rivers. It is at this stage that some learners were in dilemma of why water from the sewage treatment plant is discharged to rivers yet sewage has disease carrying germs. However, the physical facilities at this place made learners aware that the sewage is treated and made harmless and is therefore different sewage that is disposed.

The results from the table above reveal that looking and listening were dominant in this study while manipulation of objects occurred once. It therefore shows that the typical tour was a structured, narrative, tour guide directed experience in which five groups made of twenty learners moved from one place to another (Cox-Petersen *et al*, 2003). The tour guides guided learners throughout the tour and allowed learners to ask questions and to

discuss amongst themselves. This is revealed by the observation schedule above in which learners' interaction was identified. Learners interacted with the tour guide frequently during the observations but discussed with other students after the observations. The observations and the interaction denote participation and were more frequent than other activities observed during the visit. Through observation in direct contact, learners acquired knowledge about seven steps in water purification as seen in the post questionnaire. With this aspect, learners were able to state that boiling water is not enough since pH and the taste of water cannot be corrected by boiling. The assertion was also heard from learners' conversation with the tour guide.

Learner: Since at WASA water goes through several tests such as pH and the taste, I therefore regard boiling water only not effective and prefer water from WASA.

Similar to Cox-Petersen *et al.* (2003) findings, learners played a more passive role in this tour, looking and listening most of the time. However, being in direct contact with the concept under discussion enhanced knowledge acquisition. Unlike in science classroom, learners were engaged in both visual and verbal learning styles during the visit.

The observation data shows that learners were limitedly engaged in manipulation. Therefore, there were no hands on activities except when chlorine was passed from one learner to another when chlorination step was explained. However, hands on activities do not guarantee that the individual is engaged in learning activity as objects may be manipulated without the active mind on what is done (Rennie & McClafferty, 1995).

For this reason, the absence of manipulation does not mean that learning does not occur as the results reveal that learners acquired knowledge about community health as a result of the visit to WASA. However, the presence of manipulation might have increased the number of learners who gained knowledge as a result of the visit to WASA.

The explanation of several steps involved in water purification prior to the tour enriched learners' prior knowledge and learners knew about the purpose of the visit. This preview introduced learners to the concepts communicated during the visit to WASA. Griffin (1998) maintains that visual displays play a vital role in explanation of abstract concepts and therefore influence learning in out of-school-setting. The demonstrations of water purification at WASA were real and learners were able to construct their own knowledge in accordance with what they saw. The real exploration of water treatment portrayed constructivist approach in which learners were engaged in knowledge acquisition through the use of their senses (Lorsbach & Tobin 1992). Tomkins and Tunnicliffe (2001) support that the direct experiences contribute to better understanding of concepts under discussions. Again the concept of water treatment was more concrete as learners were in direct contact and listened to the explanation given by the tour guide on what is observed. Additionally, the direct observation of water purification steps captured learners' concern about the wise use of water. The question below indicated that learners were willing to save tap water after being aware that water undergoes several steps of treatment.

Learner: is it correct to use river water for washing clothes as to save tap water?

Tour guide: Yes river water could be used for washing clothes because the more tap water is used at home the more it becomes expensive for WASA to treat water.

Teaching about pollution in the classroom may not be authentic as taking learners to explore the concept under the natural environment where reality is explored. Reality is not enhanced when learners are only told about the concepts not exploring them. For example telling learners in the classroom that water is drawn from Mohokare river and purified at WASA is not real as taking learners to those places. In this study, taking learners to Mohokare river added the realism to what is being discussed in the classroom and the text books, that rivers are water sources. Learners were also told about the effects of water pollution and how pollution affects water purification process. In this notion, learners were aware that pollution increases the cost of water since more chemicals are used when the water is more polluted.

4.4 Conclusion

In this chapter, the pre and post questionnaire responses were analyzed and learners' knowledge described as enrichment or conceptual capture. Conceptual exchange was not identified even though misconceptions such as boiling kills diseases were detected, because the researcher did not use appropriate questions that would enable her to gauge if conceptual exchange had occurred. Learners' existing knowledge changed greatly through enrichment and conceptual capture as a result of the visit to WASA. However, some learners did not modify their existing knowledge due to daily life experiences that are functional on their daily bases. This study showed that learners may also develop or reinforce wrong conceptions as a result of the outdoor visits. Most learners were not aware of pollutants likely to be found in water besides germs therefore, boiling water was the commonly known purification method. However, the results of this study show that the visit to WASA made learners aware that water goes through several steps of purification and does not come automatically from the tap. Looking at the real purification steps while the tour guide explained the water treatment process influenced knowledge gain about community health. The displayed chart demonstrating seven water treatment steps also made learners aware of activities done at WASA and contributed in the effective learning environment for learners as they were informed of the purpose of the visit before the tour. Physical facilities offered the realism to concepts under study and enhanced learners' ability to acquire knowledge, as learners gained evidence through the actual observation of drawing of water from the river by machinery and the water purification process.

Chapter five

Conclusion, Reflections and implications

5.1 Introduction

This chapter presents the summary of the findings and conclusion of this study. The reflection will be based on the whole research process. Finally, the implications and the limitations of the study will be discussed and the recommendations for further research suggested. The study intended to answer the following questions

- To what extent does Form D learners' knowledge change as a result of a visit to WASA?
- What aspects of the visit influence learners' knowledge about community health?

To answer the first question, pre and post questionnaires were administered to eighty learners and interviews were conducted to a sub-sample of eight learners. Observations were done during the tour to answer the second question.

5.2 Findings from the analysis of pre and post questionnaire responses and interview transcripts.

Most learners with prior knowledge in line with accepted knowledge of science gained knowledge through enrichment. This may be because enrichment is the simplest form of conceptual change (Vosniadou, 1994) requiring no modifications but just addition of the missing information. Most learners with prior knowledge which was wrong or scanty attained knowledge through conceptual capture. However, the study showed that learners with incorrect prior knowledge may not successfully acquire as much knowledge as learners with prior knowledge that relates with acceptable science knowledge. Therefore, prior knowledge in some cases may hinder learning during outdoor visits as conceptual change failed to occur. Mikkila-Erdmann (2000) supports that prior knowledge may hinder or facilitate learning depending on the alternative concepts held by the learner.

Learners' prior knowledge in some cases indicated that daily life experiences may be scientific but not explicitly defined at home. As an illustration, one learner knew that jik is added to water at home but did not know that bleaches such as jik are made of chlorine that kills germs.

Even though some learners gained knowledge as a result of the visit to WASA, some learners' misconceptions were resistant to change. The scenario is similar to Lelliott's (2007) explanation that during the visit, misconceptions can either be unaltered or reinforced. For instance some learners stated that boiling kills chemicals while others stated that water has diseases. These two explanations are incorrect. Some learners rectified them but others did not restructure their wrong explanation showing that naive ideas may sometimes be functional to the learner and cannot be corrected even when the new knowledge is communicated. Ozdemir & Clark (2007) support that learners' existing ideas may be functional that learners might not feel the need to change what they know.

The results also showed that learners gained knowledge about different types of water pollutants and how pollutants are removed in water treatment. The common pollutants known by learners are germs but as a result of the visit, learners acquired knowledge that water can also contain chemical pollutants. As a result of the visit to WASA learners realised that other than boiling water, purifying stations such as WASA produce water safe for drinking. Similar to McPeak's (2009) finding, the visit enlightened learners that there are several steps involved in water purification, therefore water is not a limitless resource. Before the visit to WASA, learners did not associate tap water with river water instead, they believed that river water is only for people in the rural areas. It is after the visit that learners answered that river water is 'purified' at WASA and used for domestic purposes. The word 'purified' appeared on learners' responses after the visit and shows that knowledge was acquired as a result of the visit.

In this study, the results revealed that not only misconceptions hinder learning but the correct scientific concepts may also hinder the acquisition of new science knowledge when learnt in isolation (Lelliott, 2007). For instance, a learner held the correct statement that sewage is harmful but isolated that idea from the new idea that the water from the sewage plant can be purified and be made harmless enough to be released into rivers and

be used for domestic purpose. The new information about sewage treatment isolated from the already known ideas restricted learners' ability to acquire knowledge communicated during the visit. Therefore learners' prior knowledge and the new knowledge remained separate.

Some few learners confused some concepts explained during the visit even though they were in direct contact with concepts under study. For example some learners stated that chlorophyll is added to water to kill germs. The learner misconstrued the word 'chlorine' and said chlorophyll. This error can be corrected by a post visit discussion in the classroom. Therefore, the importance of the suggestion by Brand & Reiss (2006); DeWitt & Storksdieck (2008) and Pedretti (2002) that both formal and informal education should complement each other was revealed. Additionally, during the explanation by the tour guide so much information was given to learners such that got the information mixed up. For instance, one learner stated that in chlorination, bad taste is corrected instead of explaining that chlorination is the last step of water purification in which germs are killed.

The findings explained above, reveal that overall learners gained knowledge as a result of the visit to WASA. However, others developed misconceptions. The forms of conceptual change identified from learners' responses were enrichment and conceptual capture. There were also incidences when the correct knowledge changed to alternative conceptions and a few cases where there was no change in learners' conceptions at all.

5.3 Findings from the analysis of the observation schedule

The physical facilities like the machine drawing water from the river provided evidence for information communicated at WASA that rivers are the main water sources. Learners as a result of the visit to WASA acquired knowledge that water drawn from the rivers is purified before use and supplied to taps. Therefore taps are not the main water sources. The actual observation of the machines drawing water from the river changed learners' naive knowledge that rivers are only useful for people in the rural areas.

The display showing water purification steps and the short pre-tour briefing oriented learners about the purpose of the visit thus acted as the advance organizer. The information written on the chart helped learners to acquire information communicated during the tour as they referred to their notes. The illustrations on the displayed chart were visible and colourful thus attracted learners' attention to read and take notes.

Collaborative learning through participation contributed in knowledge gain during the visit to WASA as learners received help from their peers. With participation, learners became aware of their own knowledge as they interacted verbally amongst themselves asking questions. The results showed that verbal interaction and the observation are the prevalent activities during the visit and influenced the acquisition of knowledge during the visit. This was recognised during the observations as learners asked questions in accordance with tour guide's explanation. After the observation, learners discussed amongst themselves on what they observed.

From the observation schedule, manipulation activity was captured once and most of the time learners looked at the demonstration and listened. The absence of manipulation and worksheets might have contributed to learners' inability to remember some of the concepts explained during the visit. Therefore there are other aspects of the visit that might influence learners' knowledge about community health other than the ones explained in this study. In this notion, the visit was passive but resulted in change of learners' existing ideas due to observation of real science demonstrated at WASA which stimulated learners to ask questions that reflected a critical thinking. Even though hands-on activities were not there, learners' minds were on concrete experiences at WASA. The notion conforms to Rennie and McClafferty (1995) that hands-on activity does not necessarily mean minds-on. Observations of concrete experiences did contribute to learners' ability to gain knowledge during the visit.

The other important finding that emerged from this study is that the the realism of concepts under study motivated learners as they eye witnessed the scientific concepts. As a result, learners' willing to learn increased as they asked questions and discussed amongst themselves. Learners' motivation might have contributed to learners' ability to acquire knowledge communicated during the visit as Anderson (2001), Lelliott (2007), Piscitelli,

Zoldosova & Prokop (2006) found in their study that out-of-school context increased learners' interest to study.

The findings from the observation schedule indicate that physical facilities, displays on water purification steps, participation and experiences available at WASA are the aspects of the visit that influenced learners' knowledge about community health.

5.4 Implications

The outlined findings from this study have implications for schools, teachers and tour guides at WASA. The implications are explained below.

Even though the study indicates that learners gained knowledge as a result of the visit to WASA, some naive ideas were reinforced because the tour guide did not consider learners' prior knowledge during the visit. For effective learning to occur in outdoor visits, learners' alternative concepts should be incorporated as Dal (2007) states that the barrier to learning may be caused by learners' held conception not in line with accepted knowledge of science. It is therefore, anticipated that learners could have attained meaningful learning when their existing knowledge was considered during the visit. For this reason, teachers should not play the passive role in outdoor visits but should assist the tour guides to incorporate learner's ideas in information communicated during the visit. Consideration of learners' naive conceptions may not only eliminate misconceptions but may enable tour guides to capitalize on learners' existing ideas as to facilitate learning (Lewis & Williams, 1994).

Teachers should also know learners' misconceptions before the visit to WASA and communicate them to the tour guides. The tour guides should therefore put an emphasis on learners' alternative conceptions. For instance there were some learners who did not change their conception that "diseases are found in water". Knowing this alternative conception, the tour guide could have emphasized that chlorine kills disease "causing" organisms such as bacteria that cause cholera therefore the actual disease cholera is not killed.

The authority of WASA should introduce the hands on activities at WASA so as to assist learners to hold the information communicated during the visit for a longer. For example the session may include the experiment in which learners on the small scale do all steps involved in water purification. Even though hands on does not mean minds on, the inclusion of hands on activities may increase the learning styles of learners during outdoor learning as some learners may easily remember information communicated through manipulation of objects.

The discussions made by learners during the tour engaged learners in social construction of knowledge as more knowledgeable learners shared ideas with less capable learners. Therefore, it is important for either the tour guide or the teacher to listen to learners' discussion and act as the facilitator as to avoid the wrong interpretation of concepts under study. There were no worksheets guiding learners on what to do. Therefore, teachers should prepare the worksheets for outdoor sessions as they may facilitate learning (Nyamupangedengu, 2009).

In this study, the tour guides were in front and the teacher's voice was only heard during the behavioural management. Since teachers are more informed with their teaching program, they should be involved in the running and the design of the visit so as to assist the tour guides with explanation of concepts during the visit. Besides that learners' questions were only answered by the tour guide even though the teacher may be better than the tour guide to connect the new information communicated during outdoor learning with concepts learnt prior to the visit. The teachers' contribution during the visit may also avoid isolation of concepts that tend to result in learning barrier.

5.5 Reflection

The sample used in this study considered learners in urban areas. The selection criterion used to choose interview participants was based on learners' questionnaire responses only and could have been biased since there are some students good in expressing themselves through talking than writing on paper. After going through learners' responses for question six, the post questionnaire showed that learners might not have clearly understood the question. It therefore shows that the question was ambiguous as learners

interpreted it as if it says water from the sewage plant could be used directly for domestic purpose. However, the question intended to highlight that it is proper for water treated at sewage plant to be discharged into rivers and used for domestic purposes. Therefore, learners' responses that the water is not hygienic were categorized as the incorrect response yet the question was not clear and might have affected the results. Apart from that, question one that said, except for farming purpose how is river water important to you, has been a general question. Therefore some learners stated the importance of river water in general not in association with tap water. For the interviews, the researcher focused only on verifying if there was knowledge gain not on conceptual exchange. Hence could not ascertain cases of conceptual exchange.

Since the researcher is a teacher by profession, some interview questions led learners as teachers normally do in their classroom for learners to understand and this might have affected the results. An hour spent during the visit might have been too short to capture all aspects of the visit that may influence knowledge gain therefore, some of the aspects might have been left out. Moreover, the tour guides were internship students who might not have known the important features that facilitate learning at WASA. Therefore, some information not clearly captured by learners during the visit might have been due to inexperienced tour guidance offered by the internship students.

5.6 Suggestions for future research

This study involved one school therefore the research findings cannot be generalized instead further research should be done with other schools in different contexts.

5.7 Concluding remarks

In this study, I have shown in detail the extent to which form D learners' knowledge change as the result of the visit to WASA and the aspects of the visit that influence learners' knowledge about community health. The study showed that learners' knowledge changed greatly as a result of the visit to WASA. Before the visit, learners did not know about several steps involved in water purification and after the visit some steps explained during the tour were not clearly understood by some learners. Therefore the need for formal education as a follow up to what learners learn during the visit was made evident. It therefore supports other researchers' view that outdoor visit cannot solely be used in

teaching of complex topics since the wrong conceptions may be attained during the visit. For this reason formal learning is needed for correction of wrongly acquired information. The study has also shown that physical facilities, participation and displays are the aspects of the visit that extremely influence learners' knowledge about community health. The results revealed the importance of physical facilities in learning since they offer the concrete experience and add realism to the concept under study. Learners' prior knowledge has been found to be the crucial part of learning since learners relate the new information into what they already know. Therefore not only in the science classroom should learners' knowledge be considered, but even in outdoor learning the existing knowledge should be incorporated. The participation through the verbal interaction amongst learners has been prominent in this study and contributed in sharing of ideas amongst learners as knowledgeable learners explained to others. The chart displayed at WASA acted as an advance organizer for the information communicated during the visit. Even though the visit was passive, some of learner's existing ideas not in line with accepted knowledge of science were rectified.

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Appendices

Appendix 1: Questionnaire

Number	
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1. Except for farming purposes how is river water important to you? Explain your answer.

2. Some villagers in rural areas collect water from uncovered wells, but the water is sieved before drinking to make it clear. Is this water safe for drinking? Explain your answer.

3. Is water which has the runoff from agricultural fields safe for drinking? Explain your answer.

4. Pit latrines are encouraged in Lesotho, what do you think is the purpose of this?

5. Some people have no access to clean water, what is the purpose of them boiling water before use?

6. Can water that has been treated by sewage plant be used for domestic work (eg. Preparing food)? Explain your answer.

7. Could you describe two things that you learned from the visit to WASA about

a) Water treatment

b) Sewage treatment (Cox-Person *et al*, 2003)

Appendix 2: Interview questions

1. Where does tap water come from?
2. Now that you know about water sources, what can you say about the importance of pit latrines?
3. Do you think boiling untreated water is enough for drinking purposes?
4. Even though river water is not paid can you encourage people to use it?
5. Do you see any importance of several steps involved in water treatment?

Appendix 3: Observation schedule 3

Time <i>(Extra five minutes is for movement of learners from one place to another)</i>	Verbal interaction Learner + tour guide	manipulation	Observation	Verbal interaction learner + learner
11:00-11:10				
11:15-11:25				
11:30-11:40				
11:45-11:55				
12:00-12:10				
12:15-12:25				
12:30-12:40				

Appendix 4: Interview Transcription

T: where does tap water come from?

S: From my knowledge I think tap water comes from the river

There are the ... are used to deliver water from the river but before that before water in order for water to be in the tap the water has to be clean to make sure that there are no bacteria for people not to be harmed by that water.

T: Now that you know about our water sources being the rivers, what can you say about the importance of pit latrine, can you connect why Lesotho is encouraging people to built pit latrines.

S. Oh, I think is because some people may faeces in water in the river so that is why pit latrines are encouraged in Lesotho so that the water cannot be dirty with faeces, some people use.....

T. but that water from the river you learned that it has been treated, so why is it the concern that this faeces should not come to this water and pollute this water why do you think is the main concern, it is also the concern of WASA for people not to pollute river water, why do you think is the main concern?

S: even if it is clean madam you know faeces is the bad thing, it might not be that cleaned madam, but there are some things which will still appear in the water so it will still harm the people. People will suffer from the diseases.

T: so you are saying that even though water is treated at WASA, there are chances that this sewage can even be seen after the water has been treated.

S: it cannot be seen but there will still be things that are bad in the water even if it is cleaned madam

T: do you think boiling untreated water is enough for drinking purpose

S: I don't think it is enough, it might be no good but I don't think it is enough because there will still be some bacteria in them, maybe the bacteria will not die but will stay as if they die and when they are in the stomach they will be alive again.

T: so I am concerned about this one, It is not only the bacteria that are found in untreated water, what do we get from untreated water ? we can find germs which are bacteria. so i say not only do we get bacteria in untreated water, what do we get. For instance drinking water near the fields where chemicals are used, so do you think boiling water is enough.

Do you think boiling removes chemicals.

S:No it is enough.

T: from what i told you what can you say?

S: about the chemical?

T: Do you think boiling also removes chemicals?

S:Boiling

T:yes

S: it might madam it might kill some but i don't think it is enough maybe if the water is boiled and maybe chemicals like chlorine are added. To make sure that chemicals are not there water has to be tested.

T: Even though river water is not paid can you encourage people to use it untreated ?

S; No

T: Why

S: Like as i said some people use this river water to help themselves some can wash there it is not safe at all because even if they pollute something there, there might be some sort of dirty things you know the rubbish is being polluted in there some rubbish like the perfumes may not be finished, so the chemicals will be there so if they use the water from the river the water may harm themselves and have disease.

T: sieving this water before use what can you say ?

S: Even if they sieve the water it might not be good because they might not be sure if the water is cleaned, this water may be sieved with this big things, but there are small particles in the water and could be chemicals or bacteria which are not seen.

T: Now that you know that water does not come automatically come from the taps what can you say about the wise use of water or to this people polluting water.

S: they should not do that because the river is the most source of water if they pollute water we will not have water and water is very important in our lives if we don't have water we don't have live, if they have the dirty things you should just burn them.

T: so you said we shouldn't pollute water and people should use water wisely, but the other person can say WASA is cleaning that water therefore i can pollute it. What can you say to that person saying that.

S: I can say even if WASA is cleaning that water it might not be cleaned can have bacteria and chemicals.

T: Do you see any importance of several steps followed in water treatment at WASA

S: Yes madam, because from my understanding i can see that the water is cleaned with those steps, when chlorine is added coagulation you can see that it is good rather than boiling it only.

Appendix 5: Learners' consent letter

University of the Witwatersrand

Wits School of Education

Informed Consent Form for Conducting Research

Research Topic: The impact of a visit to Water and sewage Authority on learners' knowledge about community health.

I, _____ agree to participate in this study to be conducted by Maretsepile Molahloe of the University of Witwatersrand for the research on the impact of a visit to water and Sewage Authority on learners' knowledge about community health. I realize that no harm will result from my participation in this study, and that the study is being conducted for purposes of improving the teaching of Science in our schools. I give permission for the material to be used for research or teaching and learning of science only.

I am not forced to participate and understand that I may withdraw from the study at any time. I understand that everything I say will be kept confidential by the researcher, and my real name will not be used in the study. Real words from me may be used in the research report as quotes, but they will be reported so that my identity is not known. Any specific individuals or courses I refer to will be given names that are different from their own. I understand that the results of the study may be published, but my name will remain unknown.

Name: _____

Signature: _____

Date: _____

Appendix 6: Parents' consent letter

University of the Witwatersrand

Wits School of Education

Informed Consent Form for Conducting Research

Research Topic: The impact of a visit to Water and Sewage Authority on learners' knowledge about community health.

I, _____ the parent/guardian of _____ give permission to Maretsepile Molahloe of the University of Witwatersrand to administer questionnaire to my child. I realize that no harm will result from my child's participation in this study, and that the study is being conducted for purposes of improving the teaching of Science in our schools. I give permission for the material to be used for research or teaching only.

I am not forced to give permission for my child's participation and understand that he /she may withdraw from the study at any time.

Name: _____

Signature: _____

Date: _____

Appendix 7 :Principal’s consent letter

University of the Witwatersrand

Wits School of Education

Informed Consent Form for Conducting Research

Research Topic: The impact of a visit to Water and Sewage Authority on learners’ knowledge about community health.

I _____ the principal of _____ give permission to Maretsepile Molahloe of the University of Witwatersrand to conduct questionnaire on chosen learners in my school. I realize that no harm will result from my learner’s participation in this study, and that the study is being conducted for purposes of improving the teaching of Science in our schools. I give permission for the material to be used for research or teaching only.

I am not forced to give permission for learners’ participation and understand that they may withdraw from the study at any time.

Name _____

Signature _____

Date _____

Appendix 8: Subject teacher consent form

University of the Witwatersrand

Wits School of Education

Informed Consent Form for Conducting Research

Research Topic: The impact of a visit to Water and Sewage Authority on learners' knowledge about community health.

I, _____ the Biology teacher give permission to Maretsepile Molahloe of the University of Witwatersrand to conduct questionnaire on chosen learners. I realize that no harm will result from my learner's participation in this study, and that the study is being conducted for purposes of improving the teaching of Science in our schools. I give permission for the material to be used for research or teaching only.

I am not forced to give permission for learners' participation and understand that they may withdraw from the study at any time.

Name _____

Signature _____

Date _____

Appendix 9: consent form for the manager at Water and Sewage Authority

University of the Witwatersrand

Wits School of Education

Informed Consent Form for Conducting Research

Research Topic: The impact of a visit to Water and Sewage Authority on learners' knowledge about community health.

I, _____ the manager at Water and Sewage Authority give permission to Maretsepile Molahloe of the University of Witwatersrand to conduct study within our work premises. I realize that no harm will result from our institution being involved in this study, and that the study is being conducted for purposes of improving the teaching of Science in Lesotho. I give permission for the material to be used for research or teaching only.

I am not forced to give permission for the use of WASA vicinity in this study and understand that the research could be withdrawn at any time.

Name _____

Signature _____

Date _____

Appendix 10: Consent form for interviewed learners.

University of the Witwatersrand

Wits School of Education

Informed Consent Form for Conducting Research

Research Topic: The impact of a visit to Water and Sewage Authority on learners' knowledge about community health.

I, _____ agree to participate in interview to be conducted by Maretsepile Molahloe of the University of Witwatersrand for the research on the impact of a visit to water and Sewage Authority on learners' knowledge about community health. I realize that no harm will result from my participation in this study, and that the interview is being conducted for purposes of improving the teaching of Science in our schools. I give permission for the material to be used for research or teaching and learning of science only.

I am not forced to participate and understand that I may withdraw from the study at any time. I understand that everything I say will be kept confidential by the researcher, and my real name will not be used in the study. Real words from me may be used in the research report as quotes, but they will be reported so that my identity is not known. Any specific individuals or courses I refer to will be given names that are different from their own. I understand that the results of the study may be published, but my name will remain unknown.

Name: _____

Signature: _____

Date: _____

Appendix 11: Consent form for education officer

University of the Witwatersrand

Wits School of Education

Informed Consent Form for Conducting Research

Research Topic: The impact of a visit to Water and Sewage Authority on learners' knowledge about community health.

I, _____ the education officer, give permission to Maretsepile Molahloe of the University of Witwatersrand to conduct questionnaire and interview on chosen learners in my school. I realize that no harm will result from my learner's participation in this study, and that the study is being conducted for purposes of improving the teaching of Science in our schools. I give permission for the material to be used for research or teaching only.

I am not forced to give permission for learners' participation and understand that they may withdraw from the study at any time.

Name _____

Signature _____

Date _____

Appendix 12: Information Sheet for WASA

University of the Witwatersrand

Wits School of Education

My name is Maretsepile Molahloe. I am a researcher studying Masters in Science education at the University of the Witwatersrand. I am carrying out a study on the impact of a field trip on learners' knowledge about community health. My research should not only benefit the institutions where it is conducted, but also the Lesotho educational system in improving the teaching and learning of science.

This letter serves to request permission to conduct my study at Water and sewage Authority, form D learners being the participants. My research results will be presented in my research report and all names I use will be pseudonyms to maintain anonymity and confidentiality. In request, the copy of my research will be provided to you.

I would like to clarify that giving me a permission to conduct this study is voluntary.

Name: Maretsepile Molahloe

Signature: _____

Phone number: 0787187524/58901226

Date: _____

**Appendix 13: Information Sheet for the parent/guardian
University of the Witwatersrand**

Wits School of Education

My name is Maretsepile Molahloe. I am a researcher studying Masters in Science education at the University of the Witwatersrand. I am carrying out a study on the impact of a field trip on learners' knowledge about community health. My research should not only benefit the institutions where it is conducted, but also the Lesotho educational system in improving the teaching and learning of science.

This letter serves to request permission to involve your child in my study. This will include the questionnaire to be completed within twenty minutes and ten minutes interview with ten learners. My research results will be presented in my research report and all names I use will be pseudonyms to maintain anonymity and confidentiality. In request, the copy of my research will be provided to you.

I would like to clarify that giving me a permission to conduct this study is voluntary.

Name: Maretsepile Molahloe

Signature: _____

Phone number: 0787187524/58901226

Appendix 14: Information Sheet for biology teacher

University of the Witwatersrand

School of Education

My name is Maretsepile Molahloe. I am a researcher studying Masters in Science education at the University of the Witwatersrand. I am carrying out a study on the impact of a field trip on learners' knowledge about community health. My research should not only benefit the institutions where it is conducted, but also the Lesotho educational system in improving the teaching and learning of science.

This letter serves to request permission to conduct a study at your school being part of your organised field trip to Water and Sewage Authority. My research results will be presented in my research report and all names I use will be pseudonyms to maintain anonymity and confidentiality. In request, the copy of my research will be provided to you.

I would like to clarify that giving me a permission to conduct this study is voluntary.

Name: Maretsepile Molahloe

Signature: _____

Phone number: 0787187524/58901226

Date: _____

Appendix 15: Information Sheet for Lesotho Department of Education

University of the Witwatersrand

Wits School of Education

My name is Maretsepile Molahloe. I am a researcher studying Masters in Science education at the University of the Witwatersrand. I am carrying out a study on the impact of a field trip on learners' knowledge about community health. My research should not only benefit the institutions where it is conducted, but also the Lesotho educational system in improving the teaching and learning of science.

This letter serves to request permission to conduct a study at your school, form D and E learners being the participants. This will involve the questionnaire to be completed within twenty minutes and ten minutes interviews on ten learners. My research results will be presented in my research report and all names I use will be pseudonyms to maintain anonymity and confidentiality. In request, the copy of my research will be provided to you.

I would like to clarify that giving me a permission to conduct this study is voluntary.

Name: Maretsepile Molahloe

Signature: _____

Phone number: 0787187524/58901226

Date: _____

Appendix 16: Information Sheet for participants

University of the Witwatersrand

Wits School of Education

My name is Maretsepile Molahloe. I am a researcher studying Masters in Science education at the University of the Witwatersrand. I am carrying out a study on the impact of a visit to Water and sewage Authority on learners' knowledge about community health. My research should not only benefit the institutions where it is conducted, but also the Lesotho educational system in improving the teaching and learning of science.

I am inviting you as form D learner to participate in my study. This will involve the questionnaire to be completed within twenty minutes and ten minutes interview. My research results will be presented in my research report and all names I use will be pseudonyms to maintain anonymity and confidentiality. I would like to clarify that taking part in my study is voluntary.

Name: Maretsepile Molahloe

Signature: _____

Phone number: 0787187524/58901226

Date: _____



Appendix 17: Ethics clearance

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa

Tel: +27 11 717-3007 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

STUDENTNUMBER:384804

Protocol: 2010ECE45C

1 October 2010

Mrs. Maretsepile Molahloe

P O Box 3

THABA BOSIU

LESOTHO

Dear Mrs. Molahloe

Application for Ethics Clearance: Master of Science

I have a pleasure in advising you that the Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate has agreed to approve your application for ethics clearance submitted for your proposal entitled:

The Impact of a visit to Lesotho Water and Sewage authority on learners' knowledge about community health.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

Yours sincerely


Matsie Mabeta
Wits School of Education

Cc Supervisor: Dr. A.D Lelliott (via email)