INVESTIGATING THE EFFECTIVENESS OF LEARNER–CENTRED APPROACH IN TEACHING AND LEARNING ACIDS AND BASES IN TWO SELECTED SECONDARY SCHOOLS IN OHANGWENA REGION, NAMIBIA

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

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APPROVAL PAGE

This research has been examined and approved as meeting the required standards for partial fulfilment of the requirements of the degree of Master of Education.

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Internal Examiner Date

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External Examiner Date

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Dean: Faculty of Education Date

DECLARATION

I, Sanio Ileni Tuyenikelao Mutilifa, declare hereby that this study on " *investigating the effects of learner-centred approach in teaching and learning acids and bases at two selected secondary schools in Ohangwena region*" is a reflection of my own research, and that this work or part thereof has not been submitted for a degree at any other institutions of higher education.

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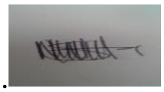
… **Sanio Ileni T. Mutilifa**………	…..….	..**24. Feb. 17**...
Name of the Student	Signature	Date

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ABSTRACT

This study investigated the effectiveness of a learner-centred approach in the teaching and learning of acids and bases at two selected secondary schools in Ohangwena region, Namibia. The study employed a quantitative approach and a quasi-experimental non-equivalent (pre-test-post-test) control group research design was used to collect data from two schools for two weeks (one at each school). Within this scope, a total sample of 80 grade 11 learners taking Physical Science Ordinary level were randomly selected from a population of 205 learners to participate in the study. Forty learners from school E formed the experimental group while the other 40 learners from school D constituted the control group. Both groups were assigned randomly. For the purpose of this study, lessons on acids and bases were conducted for four consecutive days to the experimental group. The learners were presented with hands-on activities, laboratory work such as experimentation and practical's, small-group discussions and observatory activities to enable them to learn in a more learner-centred way. The control group was taught for the same duration (four days) but using different teaching strategies, such as demonstrations, chalk and talk, question and answer, lectures, as well as whole class discussions.

Both groups were pre-tested on the first day and later post-tested on the last day (fifth day) of the lessons. The non-equivalent (pre-test-post-test) scores were used to establish the cause and effect relationship between the use of Learner-Centred Approaches (LCAs) and learners' performance on the topics of acids and bases. In addition, closed-ended questionnaire were used to evaluate the effectiveness of the teaching approaches as well as teaching resources used in enhancing learners' performance. Descriptive statistics was used to analyse the quantitative data from the pre- and post-test scores and a t-test analysis was conducted for both. Graphs were generated to present the findings from the closed ended questionnaires.

The mean results indicated that the post-test scores for the experimental group (16.5000) were higher than the post-test scores from the control group (11.200). Using small group discussions, laboratory experiments and demonstrations enhanced learners' performance in acids and bases. Furthermore, it was also noted that; using various learning activities attracted learners' interests in learning about acids and bases. It is therefore concluded that learner-centred approaches are effective in the teaching and learning of "acids and bases" as a topic in Physical Science as they enhance learners' performance. The study recommends that Physical Science teachers should make the teaching and learning of acids and bases more practical-based.

DEDICATION

This thesis is dedicated to my late grandmother, Martha Pondjeipawa Hikambe. Thank you for the wonderful upbringing; may your soul continue to rest in eternal peace. To mom and dad Mr and Mrs Mutilifa, thank you for continuing where my grandmother stopped. To my dearest sister Sonia HL Mutilifa, this is for you!

LIST OF ACRONYMS AND ABBREVIATIONS USED IN THE STUDY

DNEA	Directorate of National Examinations and Assessment
MBESC	Ministry of Basic Education Sport and Culture
NIED	National Institute for Educational Development
NSSCO	Namibian Senior Secondary Certificate Ordinary
JSC	Junior Secondary Certificate
LCA	Learner-Centred Approach
LCE	Learner-Centred Education
TCA	Teacher-Centred Approach

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Physical Science is a practical subject that is amenable to the use of the learner-centred approach (LCA) to teaching with learners playing active roles in the teaching and learning process (Doyle, 2008). Biggs (1999) identified “learner activity' and 'interaction with others' as two of four factors likely to encourage a leaner-centred approach to teaching” (p.73); whilst Ramsden (1992) believes that learner-centred is “encouraged by teaching and assessment methods that foster active and long-term engagement with learning tasks” (p.81). Like many other post-independent African countries, Namibia went through many changes after independence, politically, socially and educationally, as the nation sought to determine its own destiny. The Ministry of Education and Culture (MEC, 1993) articulated four major goals of education as access, equity, quality and democracy and states that, “As we make transition from educating the elite to education for all we also make a shift from teacher centred to learner-centred” (p.74).

According to Schweisfurth (2011) “Learner-Centred Education (LCE) has been a recurrent theme in many national education policies in the global South” (p.425). Khoboli (2007) also indicated that the education policy change is more about paradigm shifts, not only in the practices and documentation but also in personal and public knowledge of teachers. The trends of changing from a traditional (teacher-centred) approach to a learner-centred one are observed in some Southern African countries, namely, Botswana, Lesotho, South Africa and Namibia (Khoboli, 2007). In independent Namibia, education transformation as the Cape Education System was essential for numerous reasons but for the purpose of this study only the last reason for transformation will be examined, since it deals with the change from a teacher-centred to learner-centred teaching approach. The MEC (1993) and Ministry of

Basic Education Sport and Culture (MBESC) (1996) claimed that the curriculum and teacher education programmes of the Cape Education System was teacher-centred and was characterized by poor classroom practice, low learner participation and poor learner performance. This, according to Cohen (1994), could not be relied upon to promote quality education as it was based on rote learning and memorisation rather than understanding.

On the other hand, international studies carried out by for instance, Kember (2008) articulated that a long-lasting concern has been trying to persuade academics to shift from teacher-centred forms of teaching towards more student-centred approaches, in order to improve the quality of teaching and learning in schools. It is against this background that the MEC proposed learner-centred - teaching methods for basic education in Namibia. Schrenko (1994) also noted that in a learner-centred approach the learner must be at the centre of the teaching and learning processes, with learners' interests and needs being taken into account when a teacher is planning or presenting a lesson. The LCE results in learners' active participation, allowing them to engage deeply in the content (Khoboli & O'Toole, 2011), hence Namibia embraced it as a framework for curriculum and teaching at all levels of primary and secondary schooling (MBESC, 1996; Kapenda, 2007).

Learner-Centred Education can be considered as a collection of teaching methods that help learners to engage more deeply in the content and construct meaning. It is an approach to learning centred on the participation of all learners and involves responding to the learners' needs and interests as a group and as individuals (Khoboli, 2007). Several studies have been conducted in Namibia, for example, by Kasanda, Lubben, Campell, Kapenda, Kandjeo-Marenga and Gaoseb (2005), on *"The role of everyday contexts in learner-centred teaching: the practice in Namibian secondary schools"* which found that more everyday contexts are used in junior secondary than in senior secondary classes, that only a limited range of types of everyday contexts are used at both levels, and that their use often follows theoretical exposition or teacher questioning. Kapenda (2007) reported on the use of LCE in selected Mathematics classes in the Khomas region and found that teachers were to some extent following learner-centred approach in their classrooms.

Adejoke's (2007) investigation of the knowledge and practices of learner-centred methods of teaching by Physical Science teachers in the Omusati region found that teachers tend to use teacher-centred methods only a in the classroom, including question and answer, discussion and independent inquiry, and few that promoted active participation of learners in the teaching and learning process. To date, no study has been conducted on the effectiveness of learner-centred approach in learning about acids and bases in Namibian secondary schools; hence the need for this study.

According to the Directorate of National Examinations and Assessments' (DNEA) annual examiners reports for Physical Science ordinary level (DNEA, 2013, p.23), "...acids and bases were not well managed and they still remain a headache to learners*"*. That means, learners could not define acids or bases in terms of proton transfer nor distinguish between weak and strong acids and bases, learners did know the examples of acids and bases but found find it difficult to describe their effects on litmus papers and the universal indicators. This trend of poorly answered questions has continued since the Cambridge Education System to date (DNEA, 2005). In the national ranking for 2013 examinations, Ohangwena region was ranked last among the other four northern regions. An analysis of the Namibia Senior Secondary Certificate Ordinary (NSSCO) Physical Science 2013 results by the Ohangwena Education Directorate revealed that about five secondary schools in the region had performed below the nationwide average (DNEA, 2013).

Table 1.1: Statistical analysis of the NSSCO Physical Science 2013 results in Ohangwena region.

Name of Secondary School	**Performance in NSSCO-Physical Science 2013 (%)**
A	40.31
B	32.45
C	30.10
D	28.20
E	18.40

Source: www.dnea.gov.na//archive?2013,exams

1.2 STATEMENT OF THE PROBLEM

Progress towards better achievement of Physical Science grade 11 learners in the Ohangwena region has been slow. According to the annual examiners' report for Physical Science Ordinary level (DNEA, 2013), 'acids and bases' is a topic identified as being consistently badly performed and the statistics on the components of the three papers (NSSCO Physical Science) written in 2013 indicate that about 58 percentages of learners failed the question on acids and bases (DNEA, 2013).

Internationally, studies in Turkey have shown that learners usually have difficulties understanding the concepts of acids and bases. Cros, Amouroux, Leber and Fayor (2006) reported that university students tended to use descriptive definitions rather than terms of proton transfer, whereas Nakhleh and Krajcik (2004) found that secondary school learners on the North coast of Black Sea Region had difficulties identifying acid and base colours on the pH scale.

The concerns about the quality of teaching and learning in science classrooms is a global issue, but particularly so in developing countries, such as Namibia, where resources are scare. According to Qhobela and Moru (2014), these concerns include dominance of teacher-centred lessons and underuse of experimentation, compelling researchers and educators to pursue a variety of options to address them.

Various researchers have argued that effective teaching must use *more* than traditional teacher-centred approaches. For instance, Boyle and While (2004) have argued that:

> ... approaches such as study groups in which teachers are engaged on regular, structured and collaborative interactions around topics of concerns identified by the group 'are more likely to make a positive impact on their practice than traditional approaches such as question and answer used in teacher-centred approach (p.47).

Therefore, this study investigated the effectiveness of learner-centred approaches in learning acids and bases in two selected secondary schools in the Ohangwena region.

1.3 RESEARCH QUESTIONS

This study addressed the following main research question:

How effective is the learner-centred approach in teaching and learning acids and bases at a selected secondary school in Ohangwena region?

In order to fully address this research question, it has been further divided into the following sub-questions:

1. How does the use of learner-centred approach affect the Grade 11 learners' performance in learning acids and bases at a selected secondary school in Ohangwena Region?

2. What are the differences in performance of the Grade 11 learners in the two selected secondary schools?

1.4 HYPOTHESES

The study examines the following hypotheses:

H_0 – There is no significant difference in learners' performance in acids and bases topics when taught using the learner-centred approach.

H_1 – There is a significant difference in learners' performance in acids and bases topics when taught using the learner-centred approach.

1.5 SIGNIFICANCE OF THE STUDY

The findings of this study could be helpful in informing the policymakers and the Ministry of Education, Arts and Culture (MoEAC) officials in Namibia about the effectiveness of learner-centred methods in learning acids and bases in the Physical Science classrooms. The findings might also help to inform education policy and decisions-makers about putting in place strategies and support programmes to assist science teachers in effectively translate the policy of Learner-Centred Education into practice.

The information from this study could also be used by principals and teachers to incorporate learner-centred methods of teaching in their classrooms which might in turn improve the teaching and learning process. In addition, for the attainment of quality education Physical Science teachers might use this information to effectively teach using the learner-centred approaches and as such support learners to think independently and critically. These aspects are essential in mastering the strategies for identifying, analysing, solving problems and developing self-confidence, and delivering the best quality education possible (MEC, 1993).

1.7 LIMITATIONS AND DELIMITATION OF THE STUDY

The success of data collection of this study depended heavily on the cooperation and willingness of the participants, both learners from the two secondary schools and parents who gave consent to their children to attend classes after school hours. Without their full cooperation, there would be little relevant or reliable data collected.

This study was carried out with the Grade 11 Physical Science learners at only two selected secondary schools in the Ohangwena education region in Namibia, therefore the results of this study can only be generalised to the schools with similar characteristics.

1.8 DEFINITION OF TERMS

It is important to define terms that could be misinterpreted in order to establish a frame of reference in which the researcher approached the problem (Best & Kahn, 1998). For terms and concepts to carry any meaning that pertains to the study they need to be clearly defined. Accordingly, the following terms should be understood as defined here.

Learner-Centred Approach (LCA): The term, "learner-centred" describes a concept and practice in which the learners and teacher learn from one another. It is an active learning process by which learners are actively involved in the classroom (Qhobela & Moru, 2014). In this study, LCA refers to the method of teaching that involves active participation of learners in Physical Science lessons through sharing experiences with hands-on activities, laboratory practices, outdoor practices, small-group discussions and observatory activities, in particular to enable them to learn acids and bases in a more learner-centred way.

Teacher-centred methods: these are methods of teaching by which attention and activities focus on the teacher. Learners usually sit quietly, passively and listen to the teacher. The teacher is expected to have the knowledge required for the teaching/learning process which he/she has to pass on to the learners. As a result, the teacher does most of the talking and thinking during the lessons (Brandes & Ginnis, 1996; McCombs & Whistler, 1997). In this study, teacher-centred methods of teaching imply demonstrations, question and answer, lectures, as well as whole class discussions.

Performance: refers to the outcomes or the results obtained from processes, products and services that permit evaluation and comparison relative to goals, standards, past results, and other organisations (Mwamwenda, 1995). In this study, the term was used to refer to the learners' results and outcomes from Physical Science pre-test and post-test activities given to them to complete.

Students and Learners: are terms used interchangeably in this study and understood to mean those trying to gain knowledge or acquire a skill in something through study or experience in a school.

1.9 SUMMARY

The studies cited so far outlined the shift from teacher-centred approaches to a more learner-centred approach to learning, and the results are not conclusive as to whether matching learner-centred teaching approaches have an effect on learners' performance in the topic of acids and bases. It is against this background that this study was conducted to address the Namibian context by investigating the effectiveness of learner-centred approach in learning acids and bases at two selected secondary schools in Ohangwena region. The next chapter reviews the literature on the topic.

CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 INTRODUCTION

In this chapter the first section discusses the theoretical framework on which this study was based as well as the definition of the term learner-centred education. The second section addresses a review of literature concerning Physical Science Education in Namibia. The chapter also discusses the concept Learner-Centred Approach (LCA) and studies conducted locally, nationally and internationally. The state of learner-centred methods of teaching are also reviewed.

2.2 THEORETICAL FRAMEWORK

This study is informed by the theory of social constructivism developed by Vygotsky as:

> "the social contexts of learning and that knowledge is mutually built and constructed. By interacting with others, students get the opportunity to share their views and thus generate a shared understanding related to the concept" (Kalpana, 2014, p. 28).

According to Gray (1997), constructivist teaching is based on a belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information. Learners are the makers of meaning and knowledge. For Gray (1997), "Constructivist teaching fosters critical thinking, and creates motivated and independent learners'' (p.7).

On the other hand, Atherton (2013) places the emphasis of social constructivism on the learner as an active "maker of meanings" while the role of the teacher is to enter into a dialogue with the learner, trying to share the meaning of the material to be learned, and to help her or him refine an understanding until it corresponds with that of the teacher. Constructivist classrooms are structured so that learners are immersed in experiences within which they may engage in meaning-making inquiry, action, imagination, invention, interaction, hypothesising and personal reflection (Gray, 1997). For Risse (2004), the goal is to produce a democratic classroom environment that provides meaningful learning experiences for autonomous learners. Therefore, constructivism requires a student-centred classroom and involves a constructivist student-centred approach which places more focus on students learning than on teachers teaching (Kalpana, 2014).

Other qualities of a constructivist classroom are democratic and have an interactive nature, as highlighted by Gray (1997), for whom a democratic classroom environment emphasises shared responsibility and decision-making. It is also argued by various scholars that practices which typify democratic classrooms include acknowledgement of the importance of human experience in learning; accommodation of small groups, individuals, and, occasionally, the whole class in instruction; creation of an environment that supports the active involvement of students in collaborative and empowering activities such as the exchange of ideas and opinions, and responsibility for making decisions about learning and for generating flexible rules; and teacher focus on students' learning rather than on teacher performance (Lester & Onore, 1990; McNeil, 1986; Dewey, 1916; Bentley & Dewey, 1949). On the other hand, Taber (2011) argues that an interactive student-student and student-teacher dialogue is important in a constructivist classroom.

2.3 DEFINITION OF LEARNER-CENTRED APPROACH

The changes in the education system, especially with the emergence of online schooling, has led to many controversies as stakeholders argue about approaches that are most efficient and effective (Al-Zu'be, 2013). Among these is one between the learner-centred and teacher-centred approaches to education (Froyd, & Simpson, 2008).

The two approaches may be defined as follows:

> Leaner-Centred Approach is defined as an approach to the teaching and learning process which supports the concepts of a learner as an active participant and supports the instructor's additional competencies as mediator and facilitator of learning through learner support techniques and practices (Weimer, 2002).
>
> On the other hand, the Teacher-Centred Approach is an approach that portrays learners as basically passive while the teachers are active since teachers are the main focus in this approach which is considered sensible since the teachers are familiar with the language which the learners are not. In this case, the students are less engaged during the learning process (Al-Zu'be, 2013).

Therefore, active learning, student engagement and other strategies that involve students and learning are called 'learner-centred' (Murphy, 2008). Quobela and Moru (2014) regard active-learning as a process in which learners are actively involved in the classroom. On the other hand, O'Neill and McMahan (2005) highlight several themes related to the definition of learner-centred approach notably, some people viewing learner-centred learning as the concept of the students' choice in their education. Others see it as being about the student doing more than the teacher; however, other scholars such as Weimer (2002) have a broader definition which includes both of these concepts but take account of the shift in the power relationship between the student and the teacher.

On the other hand, Froyd and Simpson (2008) argue that a learner-centred approach is an instructional approach in which learners influence the content, activities, materials, and pace of learning. To them, this model places the learner at the centre of the learning process. Similarly, Hua, Harris and Ollin (2011) see the teacher's role as providing learners with opportunities to learn independently and from one another, and to coach them in the skills they need to do so effectively.

Learner-Centred Education (LCE) includes techniques such as substituting active learning experiences for lectures; assigning open-ended problems and ones that require critical or creative thinking that cannot be solved by following text examples; involving learners in simulations and role plays; and using self-paced and/or cooperative (team-based) learning (Al-Zu'be, 2013). According to Bajah and Asim (2002), guided-discovery learning is a better approach to acquisition of knowledge in the teaching and learning process than conventional methods such as lectures. If it is properly implemented, LCE can lead to increased motivation to learn, greater retention of knowledge, deeper understanding, and more positive attitudes towards the subject being taught (Froyd & Simpson, 2008).

2.4 LEARNER-CENTRED EDUCATION AND ACADEMIC ACHIEVEMENT

Handelsman, Ebert-May, Beichner & Bruns. (2004) conducted a study with 100 North Carolina state University students, with the aim of demonstrating the effectiveness of active-learning techniques in the Physics introductory course. Their study discovered that active participation in lectures and discovery based-laboratories helps students to develop the habit of mind that drives science. However, most introductory courses rely on "transmission-of information", lectures, and "cookbook" or laboratory exercise techniques that are not highly effective in fostering conceptual understanding or science reasoning (Handelsman et al., 2004). Interestingly, the study results also show that students who learnt Physics through interactive approaches to lecturing significantly enhanced learning, and although time allocated to inquiry-based activities reduces coverage of specific content it does not reduce knowledge acquisition as measured by standardised exams. Thus, many students demonstrated better problem-solving ability, conceptual understanding and success in Physics course compared to those who had learnt in traditional, passive formats

(Handelsman, Ebert-May, Beichner & Bruns, 2004, p.521). The findings of Handelsman et al. show that active learning enhances learning

Meanwhile, Gosling (2003) conducted a case study of 150 Master's students at Imperial College in London with the aim of encouraging them to take a deep approach to learning through a combination of teaching and learning methods. The results of his study show that all the participants seemed comfortable with the lecture part of the sessions while many struggled with the more interactive sessions; however, the group style of these sessions seemed to ease this process (Gosling, 2003, p.12). The study also indicated that students were from different countries, academic backgrounds, cultures, and teaching and learning traditions. Hence, it was a challenge to ensure sufficient exposure and learning for the diverse group, as they would need a deeper understanding of the concepts involved, hence the results (Gosling, 2003, p.13). More recently, McCabe and O'Çonnor (2014) conducted a qualitative study in Ireland titled, "*Student-centred learning: the role and responsibility of the lecturer*" with a group of 36 students and 10 lecturers. The aims of their study were to explore the facilitation role of the lecturers and identify strategies that have enabled effective transition from traditional pedagogical practice. Their findings reinforced a core interpretation of student-centred learning as a shift in responsibility from a lecturer to students, with the latter assuming greater ownership of their learning. The students in this study were active participants, demonstrating the characteristics of autonomous, proactive and constructive engagement characteristics that have been reported in studies elsewhere (Hua, Harris, & Ollin, 2011; Macaulay & Nagley, 2008; Hybels & Weaver, 2005).

Whilst there are underlying dimensions common to both traditional and student-centred approaches (Kember, 2009). Kember (2007) emphasised that lecturers in this study stressed the importance of balance between traditional and student-centred approaches to ensure a level of contribution that encourages motivation and active participation. Hence, the study findings confirmed that the classical foundations of teacher competencies are still of significant importance, not least since "… conceptions of teaching influence approaches to teaching which impact on students' approaches to learning, and in turn affect learning outcomes" (Kember, 2009, p. 2).

Unlike the investigation of the present study, McCabe and O'Connor (2014) studied learner-centred learning from a different angle. That is, they included in their study lecturers' facilitation and how their pedagogical knowledge influenced the transition from traditional approaches of teaching to a learner-centred approach. McCabe and O'Connor study reveals that all participants were active, demonstrating the characteristics of autonomous, proactive and constructive engagement, which in turn proved to have enhanced students' learning.

These studies results (Handelsman et al., 2004; Gosling, 2003, Mccabe & O'Connor, 2014; Kember, 2009) confirm positive influences of learner-centred learning approaches to teaching on academic performance, attitudes toward learning, and persistence in programmes. In light of the growing evidence on the effectiveness of learner-centred learning approaches, Handelsman et al., (2004) found mounting evidence that supplementing or replacing lectures with active learning strategies and engaging learners in discovery and scientific process improves learning and knowledge retention. Robnson (2012) also asserted that learner-centred learning is concerned with the learner's needs, abilities, interests, and learning styles, with the teacher as a facilitator of learning, helping learners access and process information.

As noted in Gosling (2003):

> ...as teachers use the learner-centred approach they recognize that, other than subject content which all learners must learn in order to pass, each learner approaches the

> subject from their own viewpoint, their own unique past experience and their own understanding of themselves and their desires (p.163).

The learners' personal identities, influenced by factors such as gender, age, past educational experience and achievement, class, ethnicity, nationality, sexual orientation, self-perception, goals, abilities and disabilities, and language skills inevitably shape their learning (Gosling, 2003).

Learner-centred approaches give the learner increased responsibility and autonomy as they rely on active as opposed to passive learning, and there is an emphasis on deep learning and understanding (Robnson, 2012). In addition, there is an increasing body of evidence of the effectiveness of learner-centred approaches to learning, with Kember (2009) providing evidence of the effectiveness of a multi-pronged initiative at a research-intensive university in Hong Kong, particularly in the context of mathematics, he concluded that:

> Disciplines which have traditionally reserved the initial parts of programmes for building a solid foundation of basic knowledge, for which there are accepted positions, have tended to find it more difficult to introduce active learning experiences than those in which knowledge is more contested. Disciplines which rely principally on more didactic forms of teaching run the danger of reinforcing the preference for passive forms of learning which many learners assimilate during their schooling. (Kember, 2009, p.12)

Thus it is evident in the context of Mathematics, that there can be additional barriers to introducing learner-centred approaches, as shown in the above examples of how such barriers have been overcome in a variety of universities and contexts. An important aspect of adopting student-centred approaches is in ensuring that the curricula are inclusive, helping "the process of developing, designing and refining programmes of study to minimise the barriers that students may face in accessing the curriculum (McConnell, 1989). However, this is not an exception to Physical Science, as these subjects became more closely connected, though their methods remain different. One may describe the situation by saying that the mathematician plays a game in which they themselves invent the rules while the physicist plays a game in which the rules are provided by nature, but as time goes on it becomes increasingly evident that the rules which the mathematician finds interesting are the same as those which nature has chosen (McConnell, 1989).

2.5 METHODS OF LEARNER-CENTRED EDUCATION

A number of methods are associated with learner-centred education Brandes & Ginnis, 1996; Bruce & Marsha, 1996; Glasgow, 1996; Dunne & Wragg, 1997), but no single one is superior, particularly in terms of student performance. Consequently, in LCE, methods of teaching must be matched to objectives and intended tasks for efficiency and effectiveness. Some learner-centred methods of teaching which are mostly relevant to the teaching and learning of science, particularly Physical Science, are discussed below.

Practicals and Experimentation are important components of coursework and practical work in Physical Science (Kagan, 1995; Dunne & Wragg, 1997). For example, in Experimental Techniques, learners are required to use the appropriate apparatus for the measurement of time, temperature, mass and volume under the guidance of their teacher. In acids and bases learners are required to use indicators (paper or solution) for different reagents to determine their pH values in relation to the colour change. They can also carry out reactions of acids with metals, metal carbonates and with bases. Learners can do the work individually or as a group.

The purpose of an experimentation method of teaching is usually to help the learners to make a discovery, test a theory or demonstrate known claims by undertaking a scientific procedure. This method of teaching can help learners to try out new things practically, thus gaining a better insight into the learning content (Katz & Chard, 1990). Johnson and McCoy (2011) confirmed that when students discover new evidence during experiments, it gives them positive attitudes towards investigations and experimentations in the science classroom.

Group Work is a technique that uses interactions between learners as part of the learning process. Students are divided into groups of three or four, depending on the size of the class. The groups are assigned to specific tasks to perform under the supervision of the teacher. It gives them the opportunity to work together (Kagan, 1995; Brandes & Ginnis, 1996; Dunne & Wragg, 1997; Cullingford, 1998; Slavin, 1994) and important social skills are developed as well as what is being learnt through the work the group is doing. The teachers can use this technique to share understanding about an issue through facilitating discussion in groups. They are involved in the process of learning by helping learners to develop skills of finding information, though the learners would also seek help or information from each other. The teacher here takes the role of facilitator, either as a participant in the group or as an outsider, almost in a consultant's role (Johnson, Johnson, & Holubec, 1993; Njabili, 1995; Brandes & Ginnis, 1996; Imasiku, 1999).

Group work is a substantial pillar of learner-centred education, with balancing efficiencies and inefficiencies in preparation and presentation, and its potential contribution to more effective learning and more confident learners and teachers is significant if it can be carried out well. It promotes logical and rational thinking, leading to systematic solutions. Responsibilities are shared among members of the group and, as such, students become accountable for their own learning and that of others (Kagan & Slavin, 1985; Njabili, 1995; Kagan, 1995; Brandes & Ginnis, 1996; Engelbrecht, 2000). According to Hailikari, Katajavuori and Lindblom-Ylanne (2008), when learners work in groups they are accountable for each other's learning as their prior knowledge in the topic influences their performance and that of their peers.

Small-group discussions are emphasised in social constructivist learning theory, with group interaction seen as a major contribution to sense-making (Driver, Guesne, & Tiberghien, 1985). Within the Southern Africa Developing Countries (SADC) region and elsewhere, policymakers continue to promote learner-centred teaching approaches (for example, MEC Namibia, 1993; Department of Education, South Africa, 2004) and active learning strategies (Kyriacou, Manowe, & Newson, 1999). In both policies and studies, discussions in small groups are advocated as important ways of implementing learner-centred approaches in classrooms.

On the other hand Bennett, Lubben, Horgarth and Campell's (2004) study on a systematic review of the role of small-group discussions in science teaching provided a synthesis of the outcomes of research on small-group discussions for improving learners' understanding of evidence in science. The use of small-group discussions is supported by a specific programme that fostered collaborative reasoning including evaluating and strengthening of knowledge claims, improved learners' metacognitive knowledge of collaborative reasoning, including their knowledge of reasoning about evidence (Bennett et.al., 2004). However, the improvement in collaborative reasoning depended on learners' perspective on learning, and learners with a *learner-as-explorer* perspective gained significantly more than peers with a *learner-as-student* perspective (Hogan, 1999).

Simulations enable learners to provoke a scaled-down estimate of a real-life situation, and allows accurate practice without the cost or the risks otherwise involved (Gredler, 1996). They may involve participant dialogue, manipulation of materials and equipment, or interaction with a computer. Laboratory experiments in Physical Science are popular topics for simulations (Jones, 1985), and provide practice in specific skills. Although they may produce anxiety for some learners, they also help most learners to actively participate in the teaching and learning process. They can be used for acquisition of information, improvement of new processes, and identification of alternatives in decision-making. They can build positive values and attitudes in learners (Jones, 1985), and as Kolb's theory of experiential learning posits, they also plays a role in transformation of knowledge (Kolb, 1984), Hence, simulations can be referred to as experiential exercises because they provide unique opportunities for students to interact with a knowledge realm.

Field trips are the logical extension of bringing part of the world into the classroom, which in turn takes the class into the 'real world'. They are useful not only because they give learners first-hand knowledge and enable them to see how a number of skills, processes, blend into a whole, but also because they can be used to provide learners with cultural experiences available in no other way. They should be directly related to a continuing unit of work and learner involvement during each step of planning helps generate interest and makes them more worthwhile (McCombs & Whistler, 1997; Van Den, Engelbrecht, Engelbrecht, 2000). Accordingly, Physical Science teachers are required to use different learner-centred methods of teaching in their classrooms to meet the demands of the syllabus and to address the needs of the different capabilities of the individual learners.

2.6 AIMS OF PHYSICAL SCIENCE IN NAMIBIAN SCHOOLS

The Subject Policy Guide for Physical Science grades 8-12 highlighted the aims and described the educational purpose of a course in Physical Science for the junior and senior secondary school levels for Namibian schools, stipulating that science teaching be continuous throughout the period a learner is at school. From the days at primary school to the final NSSCO examination in the high school a learner should have had a continuous scientific thread running through the school career. The basic aim of the Physical Science syllabus is the same for all learners, whether or not they intend to go on to study science, beyond this level. In particular, it enables them to:

- Acquire understanding and knowledge in Physical Science through a learner-centred approach
- Acquire sufficient understanding and knowledge to become confident citizens in a technological world
- Be caring about the environment
- Take or develop an informed interest in matters of scientific importance
- Develop an awareness that the study of science is subject to social, economic, technological, ethical and cultural influences and limitations, and that its application may be both beneficial and detrimental to the individual, the community and the environment
- Be suitably prepared for studies beyond the Secondary level in pure sciences, in applied science or in science-dependent vocational courses.

(Physical Science Subject Policy Guide grades 8-12, 2008)

With reference to the Subject Policy aims stipulated above, the Physical Science Syllabus should enable learners to acquire knowledge and understanding through a learner-centred approach, including in Physical Science,

2.7 LEARNERS' PERFORMANCE IN PHYSICAL SCIENCE

According to Mwetulundila (2000), "even though the Namibian government is striving to reserve the colonial legacy of under-representation of black Namibians in Science and Mathematics fields, their achievement in these subjects is still very low" (p.15). There are a limited number of studies on the performance of Physical Science conducted in Namibian schools, but the following studies presented were conducted in other parts of Africa.

Physical Science is a subject in high school that introduces learners to basic chemistry and physics principles as a vital scientific background (Dzama & Osborne, 1999). Numerous studies conducted in African secondary schools have indicated a low learner performance in Physical Science (Mji & Makgato, 2006; Dzama & Osborne, 1999; Mlangeni & Chiotha, 2014; Dhurumraj, 2013; Heeralal, 2003).

Mji and Makgato (2006) conducted a non-experimental exploratory study in Tshwane North with 70 learners in order to explore the factors associated with high school learners' poor performance, in focusing on Mathematics and Physical Science. The results identified a direct influence of teaching strategies, content knowledge, motivation, laboratory use, and non-completion of the syllabus in a year. Also another factor, associated with indirect influences, was attributed to the role played by parents in their children's education, and general language understanding in the two subjects.

Mlangeni and Chiotha (2014) also investigated factors that affect learners' poor performance in Physical Science examinations in Malawi. Their study used a sample of ten community secondary day schools. Using focus group discussions, personal interviews with learners, teachers and parents to collect data, and employing regression analysis and Pearson correlation, the results indicated that learners' performance in the un-approved schools was significantly poor and different from that in the approved ones, due to a lack of material resources, such as textbooks, scientific calculators and laboratory equipment.

In South Africa, Dhurumraj (2013) conducted a study on factors contributing to poor learner performance in Physical Science grade 12 in Kwazulu-Natal province, , with special reference to schools in Pinetown. The study employed a mixed quantitative and qualitative approach with a sample of two public secondary schools. Upon results analysis, several contributory factors were identified, notably, inadequate communication, ability of learners and educators in language of instruction, large classes, lack of qualified science educators, poor teaching methods, inadequate educator knowledge, and poor time management.

Heeralal (2003) also conducted a quantitative case study of Mandlethu School in Mpumalanga province in South Africa. His study aimed at improving the performance of Physical Science learners. A sample of nine grades 10, 11 and 12 learners, as well as one teacher, were interviewed to ascertain the causes of poor performance. The results indicated the main reasons for poor performance as difficulty experienced in grasping basic science concepts that were taught in primary school and answering questions in the examination, disruption in class, content coverage and lack of professional leadership.

Interestingly, Boyle and While (2004) argue that approaches such as study groups in which teachers are engaged in regular, structured, and collaborative interactions around topics identified by the groups as difficult, are more likely to make a positive impact on their practice than traditional approaches such as workshops and conference attendance. If learner-centred approach methods such as collaborative interactions, study groups on acids and bases are used, they should make a positive impact on the learners’ performance.

2.8 SUMMARY

The studies cited in this review were conducted outside Namibia so the results are not necessarily conclusive as to whether matching learner-centred teaching approach have an effect on learners’ performance in the topic (acids and bases). It is against this background that this study was conducted to address the Namibian context by investigating the effectiveness of learner-centred approach in learning acids and bases at two selected secondary schools in Ohangwena region.

The next chapter presents the methodology of this study.

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

This chapter presents the methodology of the study, the research design, population and sample used. The research instruments, sampling and data collection procedures, pilot study as well as the data analysis methods are also presented. The ethical considerations are detailed at the end of this chapter.

3.2 RESEARCH DESIGN

According to Goodwin and Goodwin (1996), a research design involves the most effective strategy for finding the information most appropriate to answering the research questions. This study employed a quantitative research approach and a quasi-experimental design was used to investigate the effectiveness of learner-centred approaches in learning the topics of acids and bases. A quasi-experimental research design aims at determining whether an intervention has the intended effect on a study's participants (Johnson & Christensen, 2004). Under quasi-experimental design, a non-equivalent (pre-test and post-test) control group design was used to establish the cause and effect of the relationship between the use of Learner-Centred Approaches (LCAs) and learners' performances on the topics of acids and bases. In this study, two intact classroom groups were compared from two separate schools and used as control and experimental groups.

3.3 POPULATION

The target population of the study was all 205 Grade 11 Physical Science learners at the two selected secondary schools in the Ohangwena region. The Grade 11 learners were chosen as participants because the topics of acids and bases were being taught in Grade 11.

3.4 SAMPLE AND SAMPLING PROCEDURES

A sample of 80 Grade 11 learners studying Physical Science at Ordinary level was randomly selected from the two secondary schools. From this sample, 11 B, of 40 learners at one selected school belonged to a control group and the other class 11 C, of 40 learners at a different school belonged to the experimental group. Intact classes were randomly selected by writing class names on pieces of papers and randomly picking them from a container (Cohen, Manion, & Morrison, 2011).

3.5 RESEARCH INSTRUMENTS

The instruments that were used to collect the data from the respondents included pre- tests, post-test and closed-ended questionnaires. To ensure validity, a pilot study was conducted. The research instruments were also given to the supervisor who made changes and corrections which were included in the final instruments.

Tests

Johnson and Christernsen (2004) assert that a test provides the researcher with information about what a student has learned and what he or she can do. It can also provide the researcher with information on how well one student has achieved in comparison with another, enabling rank orderings of performance and achievement to be constructed (Johnson & Christensen, 2004).

In this study, a pre-test (see Appendix C) was given to both the control and experimental groups at the beginning of the study as both learners were on similar levels of understanding in relation to the topic of the acids and bases. Intervention (by teaching) was made by allowing the experimental group opportunities to learn lesson 1, 2 and 3 (see appendix H) under acids and bases topics in a more learner-centred setting. On the other hand, the control group was taught the same lessons, with the same notes and for the same duration of four days but with a different approach (TCA). A post-test (see appendix B) was then given to both groups on the fifth day after the intervention (teaching).

Questionnaire

A questionnaire is a self-report data collection instrument that each research participant fills in as part of a research study (Patton, 1990; Johnson & Christensen, 2004; Shank, 2006). On the other hand, Hatch (2002) described the questionnaire as a useful instrument for collecting survey information, providing structured, often numerical data, being able to be administered without the presence of the researcher, and often being comparatively straightforward to analyse.

This study used a closed-ended questionnaire consisting of questions aimed at assessing and evaluating the teaching strategies and methods, teaching materials used by the researcher as well as learners' activities that might have contributed to differences in performance in acids and bases between the two groups.

3.6 DATA COLLECTION PROCEDURES

After obtaining permission from the Permanent Secretary, inspectors of education, principals and teachers at each school, the researcher explained the purpose of the study to the participants and how the test items as well as the questionnaires would be administered. On the first day, at school (E) the researcher administered a pre-test on acids and bases after school hours. Thereafter, the researcher taught the following competencies on topics of acids and bases to both the experimental group and the control group (in the afternoons) for duration of four consecutive days, each lesson was 1 hour 30minutes long:

Lesson1

- *Describe the characteristic properties of acids and bases*

- *Define acids in terms of proton transfer*

- *Define bases in terms of proton transfer*

Lesson 2

- *Describe neutrality and relative acidity and alkalinity in terms of pH (whole numbers only), measured using Universal Indicator paper*

- *Explain the difference between weak/strong acids and concentrated/dilute acids*

Lesson 3

- *Describe acids by their reactions with metals, bases and carbonates*

- *Use these ideas to explain specified reactions as acid/base (Neutralization reaction)*

- *Explain difference between alkalis and bases*

(See appendix H)

During these lessons, the experimental group learners were presented with hands-on activities, laboratory practices such as practical's, experimentations, outdoor practices such as field trips, small-group discussions and group work activities, to enable them to learn acids and bases in a more learner-centred setting. On the fifth day, a post-test and a questionnaire were administered.

At school D (control group) the researcher also explained the purpose of the research and administered a pre-test on the first day. She taught the same competencies on acids and bases using traditional teaching methods, namely, teacher-centred techniques, question-and-answer, and whole class discussions, as well as demonstrations for a duration of 1hour 30 minutes for four consecutive days. A post-test as well as the questionnaire were administered on the fifth day. To control for extraneous factors such as the researcher variables, the researcher taught both groups in the presence of a Physical Science teacher at the school to observe lessons.

3.7 PILOT STUDY

A pilot study was also conducted two months prior to the main study in order to ensure that the questions in the research instruments were clear and could be understood by all the participants.

A pilot study is a mini-version of a full-scale study or a trial run in preparation of the complete study (Baker, 2002). The latter, also called a 'feasibility' study, can also be a specific pre-testing of research instruments, including questionnaires or interview schedules (Van Teijlingen, Rennie, Hundley, & Graham, 2001). The goal of a pilot study is to test the study on small scale first so as to sort out possible problems that might lead to failure of the research procedure and minimise the risk of failure (Baker, 2002).

The research instruments were piloted in one of the secondary schools in Ohangwena Educational region that had similar performances in Grade 11 Physical Science (NSSC) Ordinary level examination as the secondary schools targeted for the main study. This selection was made in order to ensure that the research instruments (tests and the questionnaire) were understood by the participants, so helping the researcher to refine the questions in the instruments by ensuring that the items were appropriate and relevant to the research question. However, this school was not part of the actual sample in the main study.

The pilot study helped the researcher to know whether the questions asked were appropriate and relevant and determine whether the type of data obtained could be meaningfully analysed in relation to the research questions. In addition, it ensured the reliability and validity of the research instruments, as the test items and the questionnaire were given to the supervisor who made changes and corrections which were included in the final research instrument. It followed the design stipulated in this methodology chapter. After obtaining permission from the principal to conduct a pilot study, the researcher, used the same criterion as the one of the main study to select 40 learners from grade 11 doing physical science Ordinary level. This group of learners, 20 in number, were treated as the experimental group, with intervention of teaching acids and bases involved, while the other 20 were treated as the control group with no intervention of teaching acids and bases used.

The study was conducted in two weeks, with each group being taught for a week and taking a pre-test on the first day (Monday). The research thereafter taught the first, second and third lessons (see appendix H) using two different teaching approaches, and on the last day administering the post-test as well as the questionnaires.

3.8 RESULTS OF THE PILOT STUDY

The results of the pilot study indicated that the research instruments (tests and questionnaire) were valid and reliable for the study and the majority of the items were understood by the participants. Cohen et al. (2011) pointed out a possibility of errors in designing a research instrument. In this study, the pilot study revealed a need to revise the test items and the questionnaire.

The following indicates how the research instruments were changed and revised after the pilot study:

- *Research instrument 1. Post-test*. Question 10 was repeated in the post-test and question 19 was missing. These mistakes were noted and rectified in the main study's post-test item.

- *Research instrument 2. Questionnaire*. The questionnaire consisted of four categories of questions. The last category on the general summative part was not necessary for the study as it asked if the researcher made an effective science teacher and whether the course had increased learners' interest in science. Thus, the categories were reduced from four to three.

The questionnaire responses were also reduced in each category, for example in the first category:

Teaching and learning strategies: statements such as:

"The instructor was well prepared and organised." This was removed, as it was trying to evaluate the researcher but not the teaching strategy.

"The instructor used technology effectively that enhanced my learning." This was replaced with "*Small-group discussions helped me to enhance my learning*."

"Instructor encourages me to think and raise questions." This was changed to "*Questions, comments and collaborations with other learners in the lessons were encouraged*."

"The instructor was available on individual basis outside the class." This was removed as it was unnecessary for this course.

On the second category: **Evaluation of course materials** (Resources, assignments, assessments), statements such as:

"*The assignments are returned quickly enough to benefit my learning.*" This was replaced with "*The laboratory experiments and demonstrations carried out were very useful and enhanced my learning*."

The last category: **Student learning**, statements such as:

> *"This class has increased my interest in this field of study."* This was replaced with *"This class has increased my interest in learning acids and bases."* It was not necessary that the learning of acids and bases can enhance one's interest in the field of science.
>
> *"The instructor shows respect and concern for learners."* This was replaced with "*I have learned a lot in this class, and these lessons improved my performance in acids and bases*."

3.9 DATA ANALYSIS

Johnson and Christensen (2012) wrote that the analysis of data begins from the specific and builds towards general patterns, and the researcher's responsibility is to look for relations among the different dimensions in the collected data. The data collected through test items and questionnaires was presented and analysed, using reduction and interpretation of the amount of information collected (Sowell, 2001; Johnson & Christensen, 2004). The study employed descriptive statistics (mean, standard deviation and variance) to analyse quantitative data from the tests. A t-test was used in order to determine whether the use of various learner-centred teaching methods had a significant effect on the performance of the learners in acids and bases. The responses from the questionnaire were also analysed by using descriptive statistics and the data was presented in graphs with percentages.

3.10 ETHICAL CONSIDERATION

To ensure adherence to the research ethics, the researcher first obtained clearance from the University of Namibia (Research and Publications Office) (see Appendix D), and later from the Permanent Secretary in the Ministry of Basic Education, Arts and Culture (see Appendix

E). Further permission was requested from the Director of Education in Ohangwena region (See Appendix G), as well as from the principals of the selected schools.

The respondents were assured of confidentiality by informing them not to write their names on the test items or questionnaires. The participants were asked to give consent and for minors assent (See appendix F) was also obtained from their parents to allow them to participate in the study after school hours. Participants were also informed that they were free to withdraw at any time during the study, without recrimination. Data collected will be stored in a locked briefcase to which only the researcher has access and will be kept for a period of not more than five years after completion of the study. Thereafter, the hard copies will be destroyed by using a shredder while the soft copies will be deleted from memory sticks and hard drives.

3.11 SUMMARY

The study was quantitative in nature. Two classes from different schools were randomly selected. Each class from each school was taught differently with a different teaching approach. The pre-test and post-test were used to determine if there was a significant difference in performance of learners in acids and bases and the teaching approach. The closed-ended questionnaire was also used to evaluate the teaching approach and materials used in the course. The study was piloted at one secondary school in Ohangwena Education Region. Descriptive analysis and a t-test were used to analyse the quantitative data. The next chapter will present findings and discussions.

CHAPTER 4: PRESENTATION AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

This chapter presents the findings, interpretations and discussions of the study, the purpose of which was to investigate the effectiveness of learner-centred approach in learning acids and bases in two selected secondary schools. It further examines the effect of learner-centred approach in learning acids and bases as well as exploring the differences in performances of learners in the two selected secondary schools in Ohangwena Educational region, Namibia.

The chapter is divided into three main themes, namely:

Theme 1: The effect of Learner-Centred Approach in learning acids and bases

- Performances of the learners in the pre-test and the post-test when taught using a learner-centred approach.

Theme 2: Differences in performances of learners in acids and bases in the two selected secondary schools

- Differences in **pre-test performance** of learners in the two selected secondary schools.
- Differences in **post-test performance** of learners in the two selected secondary schools.

Theme 3: The effectiveness of learner-centred approach in learning acids and bases

4.2 BIOGRAPHICAL INFORMATION OF THE PARTICIPANTS

The biographical information of the participants from two selected secondary schools is presented in Table 4.1 below:

Table 4.1: Biographical information

PARTICIPANTS' INFORMATION:	**SCHOOL**	
Gender	**D**	**E**
Male	17	19
Female	23	21
Total	**40**	**40**
Age group	16-23	17-22
Ethnic group:		
Aawambo	40	38
San	0	2
Total	40	40
Geographical location:		
Semi-urban	5	0
Rural	35	40
Total	40	40

With reference to the biographical information of the participants in the table, the grade 11 leaners from school D consisted of 17 males and 23 females, between the ages of 16 and 23. All of the 40 participants from this school were from the Aawambo speaking ethnic group. Only 5 out of the 40 learners were from semi-urban areas, while the rest were from rural areas.

In contrast, school E consisted of 19 males and 21 females, aged between 17 and 22. A total of 38 learners were from the Aawambo ethnic group, while two learners were from the San group. All 40 learners from this school came from rural areas.

4.3 THE EFFECT OF LEARNER-CENTRED APPROACH IN LEARNING ACIDS AND BASES

To determine the influence of LCA on the performance of learners the experimental group scores in both test items were compared to establish the cause and effect relationship**.** The results of the pre- and post-test scores are shown in Table 4.2, below:

Table 4.2: Experimental group tests results

Descriptive Statistics		**Pre-test**	**Post -test**
N	Valid	40	40
	Missing	0	0
Mean		11.9250	16.5000
Median		12.0000	17.0000
Mode		11.00	15.00[a]
Std. Deviation		2.41138	2.24179
Variance		5.815	5.026
Range		12.00	9.00
Sum		477.00	660.00

a. Multiple modes exist. The smallest value is shown

The results in Table 4.2 shows a difference in the mean scores, median, mode, standard deviation, variance, range and sum for both pre-test and post-test.

The Mean, which tells us the average scores for each group, indicates that comparing the outcome mean of the two tests shows a significant shift causing a difference of 4.575 (16.5000-11.9250= 4.575) in the mean scores in favour of the post-test. Thus, this change was brought up by the implementation of LCA used.

The Median, which tells us about the middle score of the whole group when scores are arranged in order of size (either ascending or descending). The results of the median of the two tests reveals another shift after employing LCA; that is 12.00 in the pre-test and 17.00 in the post-test this shows a 5.00 scores increase (17.00-12.00=5.00) due to the use of LCA.

The Mode shows the most prevalent score within the whole group. The results in Table 4.2 show that, in the pre-test, most learners scored 11 out of 20 marks, while after employing the LCA the modal value had changed from 11 to 15, 18, 19 and 20 (multiple modes existed), but the lowest mode of the post-test is specifically chosen as 15. This was in order to avoid compromising the validity of the results.

The Sum shows the total of all scores obtained in the test items for each group. In Table 4.2 the pre-test sum was 477.00 while the post-sum was 660.00. This shows a large increase of 183.00, implying that the increase was brought up by the intervention used (LCA), increasing the total scores from 477.00 to 660.00 with 183.00 and so signifying an improvement in the performance.

The Range indicates the difference between the highest and the lowest scores. Table 4.2 shows that the range of the pre-test was 12, while for the post-test it was 9. This means that before employing LCA, there was a wide gap in performance, attributable to learners' prior knowledge and different educational backgrounds. After the intervention, the gap narrowed from 12.00 to 9.00, with 3.00 scores (in the post-test), attributable to LCA achieving equality by affirming learners' prior knowledge, hence equally moving learners along the learning continuum.

Standard Deviation tells us how measurements for a group are spread out from the mean (average). A low standard deviation indicates that most scores are close to the mean, while a high standard deviation indicates most scores are spread out far from the mean. The results in Table 4.2 show pre-test scores have a mean of 11.9250 and a standard deviation of 2.41138 scores away from the mean, while on the post-test the scores have a mean of 16.5000 and a standard deviation of 2.24179 scores away from the mean. A low standard deviation was obtained in the post-test, which indicates that most scores were closer to the mean in the post-test as compared to the pre-test scores.

4.4 DIFFERENCES IN PERFORMANCES OF LEARNERS IN ACIDS AND BASES AT TWO SELECTED SECONDARY SCHOOLS

To find the differences between the performances of the grade 11 learners in the two selected schools that formed part of the study, both the pre and post-test results were analysed for each school and shown in the tables 4.3 and 4.4 below:

Table 4.3: Experimental Group Results (school E)

Statistics		Pre-test	Post-test
N	Valid	40	40
	Missing	0	0
Mean		11.9250	16.5000
Median		12.0000	17.0000
Mode		11.00	15.00[a]
Std. Deviation		2.41138	2.24179
Variance		5.815	5.026
Range		12.00	9.00
Sum		477.00	660.00

a. Multiple modes exist. The smallest value is shown

Table 4.4: Control Group Results (School D)

Statistics		Pre-test	Post-test
N	Valid	40	40
	Missing	0	0
Mean		11.2000	11.2000
Median		11.5000	11.0000
Mode		12.00	11.00
Std. Deviation		1.98972	1.88380
Variance		3.959	3.549
Range		10	9
Sum		448.00	448.00

Looking at the measures of central tendencies results in Tables 4.3 and 4.4 above there are clear differences in performance between the control and experimental group**.** In the control group the mean scores in both the pre-test and post-test were the same (11.2000). The mean scores in the experimental group for pre-test (11.9250) and post-test (16.5000) differed by of 4.5750. This indicated that there was no shift or change in performances of learners when learners were taught using the teacher-centred approach as in Table 4.4. On the other hand, in Table 4.3 there was a significant improvement in the performance of learners when they were taught using LCA methods of teaching.

The mode scores in Table 4.3 (experimental group) increased from 11 in the pre-test to 15 in the post-test. This implies that more learners scored 11 out of 20 in the pre-test, while in the post-test taken by the same learners after the intervention LCA, most learners scored 15 out of 20.

Surprisingly, in Table 4.4 (control group) the mode score decreased from 12 in the pre-test to 11 in the post-test, which implies that most learners scored 12 out of 20 in the pre-test while in the post-test most learners scored 11 out of 20. The sum in both the pre and post-test scores in Table 4.4 is the same (448.00) in the control group. On the other hand, the sum in both the pre and post-test scores in Table 4.3 differs in the experimental group.

4.4.1 Differences in pre-test results of the grade 11 learners in the two selected secondary schools

The two selected secondary schools consisted of a sample of 80 learners (40 from each school). They were given pseudonyms, namely school D and school E, the former belonging to the control group while school E with another 40 learners belonged to the experimental group. These schools had similar characteristics, as indicated in chapter 3, and each school took their pre-test on the first day of the study. Table 4.5 (below) shows their results.

Table 4.5: Paired Samples Test: Experimental and control group pre-test scores

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PRE-TEST	.82500	3.17755	.50241	-.19123	1.84123	1.642	39	.109

Table 4.5 shows how the pre-test scores from the two schools were paired. In order to establish the difference in performance between two groups, a t-test was carried out to determine whether two means were significantly different from each other at a given $\alpha = 0.05$

level. The results in the table reveal that: $t_{calculated}$ to be 1.642; while the $t_{critical}$ value =3.558 in the table at α= 0.05 and degrees of freedom (df) =39. Therefore, the $t_{calculated}$ = 1.642 is less than $t_{critical}$ = 3.558. Hence; the H_0 (null hypothesis) is accepted which states: "There is no significant difference in the pre-test scores between the experimental and the control group".

4.4.2 Differences in post-test performance of grade 11 learners in two selected secondary schools

A post-test was administered to both groups (experimental and control group) on the last day of the five-day lessons. The lessons in both groups took the same duration of 1hour 3o minutes, used the same notes but different methods of lesson delivery, and activities were conducted using different methods.

Table 4.6: Paired Samples Test: Experimental and control group post-test scores

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	POST-TEST –	-5.45000	3.06301	.48430	-6.42960	-4.47040	-11.253	39	.000

Table 4.6 shows how the post-test scores from the two schools were paired. In order to establish the difference in performance between two groups a t-test was carried out to determine whether the two means were significantly different from each other at a given α

=0.05 level. The results were: $t_{calculated}$ equals -11.253 while the $t_{critical}$ value =3.558 in the table at α= 0.05 and degrees of freedom (df) =39. Therefore, the $t_{calculated} =$ -11.253 (the sign notwithstanding) is more than $t_{critical} =$ 3.558. The H_0 (Null hypothesis) is rejected and an alternative hypothesis (H_1) is accepted, which states:

> "There is a significant difference in the performance of the learners, when taught using a learner-centred approach".

4.5 THE EFFECTIVENESS OF LEARNER-CENTRED APPROACH METHODS IN LEARNING ACIDS AND BASES

Beside the pre- and post-test scores, the study used closed-ended questionnaires to evaluate the effectiveness of the teaching methods used in each group, the relevance of the course materials as well as the activities and the overall course evaluation.

Table 4.7: Closed-questionnaire responses

Statements	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
	%	%	%	%	%
1. Teaching methods					
1.1. Clear explanation of objectives	2.5	0	0	27.5	70
1.2. Difficult words explained	2.5	1.3	7.5	28.7	60
1.3. Areas of confusion addressed	2.5	5	8.8	38.8	43.8
1.4. Small group discussions	1.3	5	11.3	36.3	45
1.5. Questions and collaborations encouraged	2.5	2.5	8.8	41.3	45
1.6. Useful laboratory experiments and demonstrations	0	0	8.8	16.3	75
1.7. Useful feedback	3.8	0	3.8	43.8	48.8

2. Course materials					
2.1 Relevant notes	0	0	2.5	33.8	61.3
2.2. Useful activities	2.5	0	6.3	35	56.3
3. Overall evaluation of the course					
3.1. Active learning increased interest in acids and bases	0	0	1.3	35.5	63.7
3.2. Useful lessons	1.3	1.3	3.8	30	63.7
3.3. Learnt a lot	0	0	1.3	35	62.5

When the three key sections of the closed-ended questionnaire responses were examined individually, much information about the descriptors transpired. The following sub-sections from the key sections show the outcomes.

4.5.1 Teaching methods

Petrina (1992) argued that general models and families of teaching methods are guides for designing educational activities, environments and experiences. General models help to specify methods of teaching and patterns for these methods, depending on a number of factors such as the developmental level of students, goals, intent and objectives of the teacher, content, and environment including time, physical setting and resources.

In this study, various learner-centred teaching methods were employed in order to determine their effectiveness in learning acid and bases. The following results were obtained:

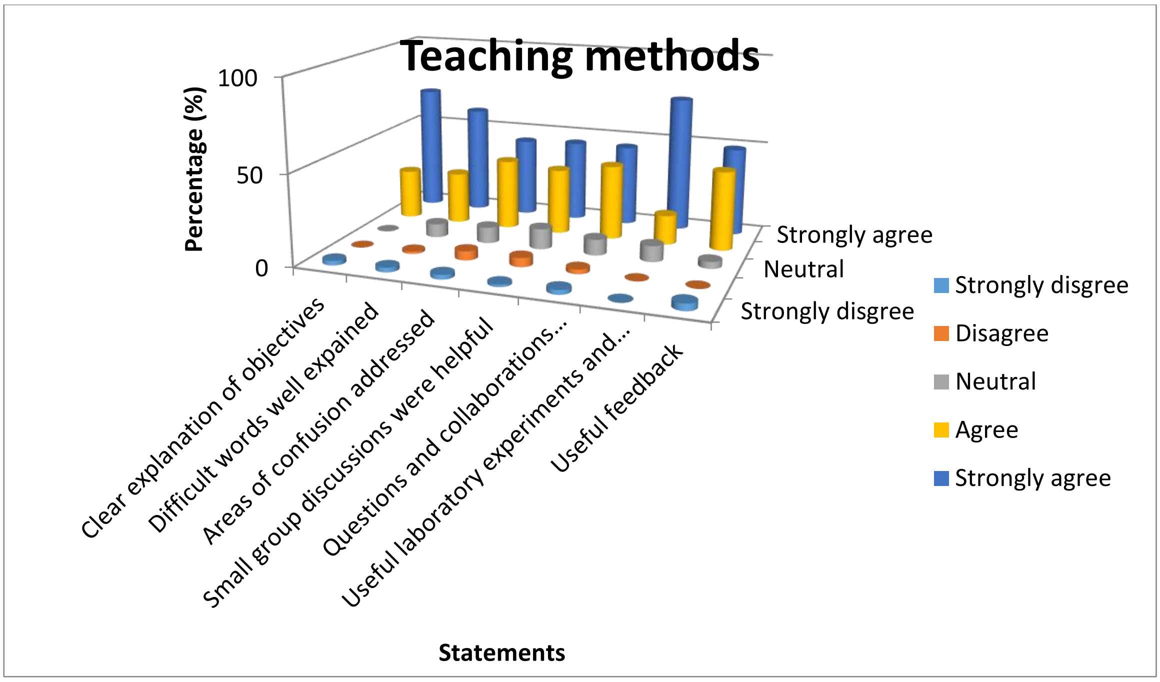

Figure 4.1: Participants' responses to teaching methods used

Figure 4.1 shows how the participants responded to the statement as to whether they agreed that the objectives were clearly explained or not. The results reveal that 70 percent of the participants *strongly agreed* and 27.5% *agreed* that objectives were clearly explained. However, about 2.5% strongly disagreed that objectives were not clearly explained. None of the participants was *neutral* or *disagreed* with the explanation of lesson objectives.

Figure 4.1 also shows how the participants responded on whether small-group discussions were useful or not. The results shows that about 81.3 percent *agreed* and *strongly agreed* that small-group discussions helped them understand the topic better. About 1.3 % of the participants *disagreed*, 11.3 % were *neutral* and the rest, 5%, *strongly disagreed* that small-group discussions were helpful.

Responses of the participants on Laboratory experiments and demonstrations according to Figure 4.1 shows that a total of 75% of participants indicated that they *strongly agreed* that the laboratory experiments and demonstrations were very helpful in learning acids and bases. On the other hand, 16.3% also *agreed* with laboratory experiments and demonstrations being helpful. This shows 91.3% of the participants who were supporting experimentation and demonstrations, however, 8.8% of the participants were *neutral* and none was *disagreeing* or *strongly disagreeing* about the statement.

4.5.2 Course materials

Course materials are building blocks for a course curriculum containing class notes, learner activities or supplementary reading or exercises. Course materials are usually in line with the learning objectives and learning activities are designed based on them and learning activities are teacher-guided instructional tasks or assignments for learners (Silberman, 1996).

Figure 4.2 below shows participants' responses on the course materials that were used in the study.

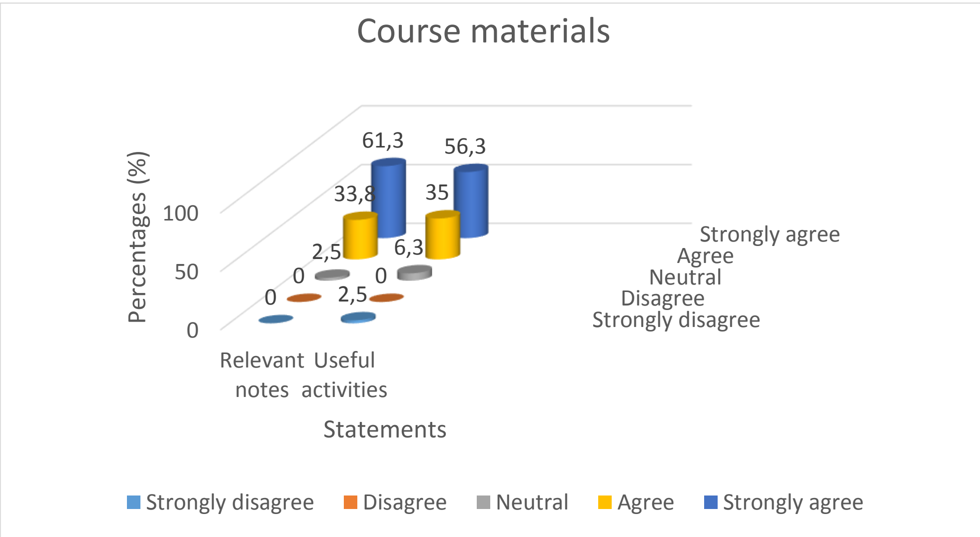

Figure 4.2 Participants responses on course materials used

Figure 4.2 shows the responses of the participants on the course materials used. A total of 95.1% indicated that notes were *very relevant* and *useful* for the course on acids and bases; however 2.5% did not find the notes *helpful* as they were *neutral* on this point. None *disagreed* that the notes were helpful. On the usefulness of the given activities, 91.3% of the participants *agreed* and *strongly agreed* that the activities used in the course were *useful*, however, 6.3% were *neutral* while 2.5% *strongly disagreed* and none *disagreed*.

4.5.3 Overall evaluation of the course

Rathke and Harmon (2011) explained course evaluations as learner's primary means of anonymous feedback on the quality of courses given. Learners say what they think and how it might be improved. Furthermore, course evaluations are also used by instructors to improve courses for future learners, to make them more relevant, and to improve their effectiveness as instructors (Rathke & Harmon, 2011).

For the purpose of this study, the responses of the participants on the overall course evaluation is shown in the figure below:

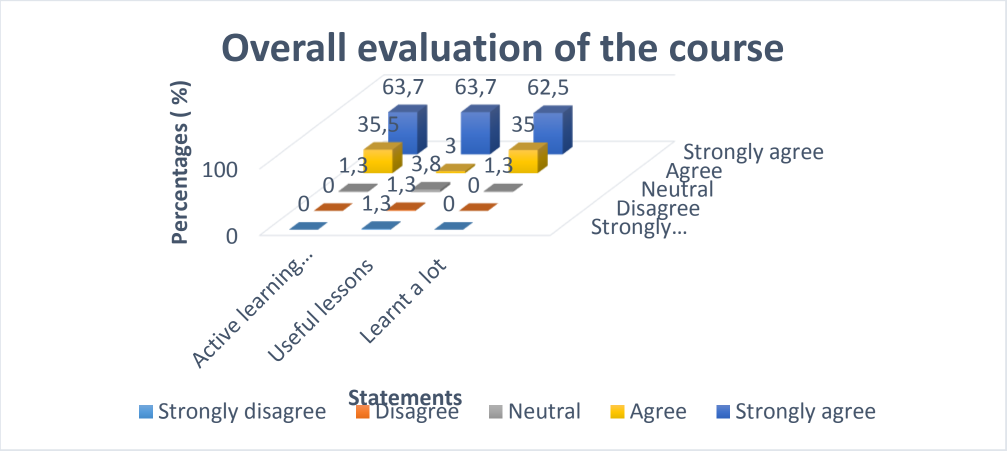

Figure 4.3 Participants responses on the overall course evaluation

Figure 4.3 shows the responses of the participants on whether active learning had an influence on their interest on the topic of acids and bases. The figure reveals that 63.7% of the participants *strongly agreed* that the active learning course has increased their interest in learning acids and bases. A total of 35.5% also indicated that they *agreed* that the course increased their interest in the topic, however, 1.3% were *neutral* on whether the course had increased their interest. Surprisingly, none *disagreed* with this statement.

4.6 DISCUSSION OF RESULTS

This section discusses the findings or results of the study according to the three main research questions.

1. **How does the use of Learner-Centred approach affect the performance of the grade 11 learners in acids and bases?**

With reference to the results in the Table 4.2, Learner-Centred Approach (LCA) affects the performance of the learners in acids and bases positively. The results show a clear shift and improvement between the pre-test and post-test in the mean scores, median, standard deviation, range and sum. That all these scores improved in the post-test is an indication that; employing LCA has made an improved performance.

These findings corroborate the report by Handelsman et al. (2004), that supplementing or replacing lectures with active learning strategies and engaging learners in discovery and scientific process improves learning and knowledge retention. There was also a significant improvement in the range of scores and performances of both tests, that is 12.00 in the pre-test and 9.00 in the post-test. This indicates a wide gap in knowledge between learners' pre-test scores (12) which has narrowed to 9 in the post-test scores due to the use of LCA. This means that in the pre-test some learners had prior knowledge on the topic, with acids and bases being taught in Junior Secondary phase (JS) grade 9 and 10. Some learners scored lower than others due to their various Junior Secondary educational backgrounds.

In a study on the " The relevance of prior knowledge in learning an instructional design" at Helsinki University in Finland by Hailikari, Katajavuori and Lindblom-Ylanne (2007) it was submitted that prior knowledge from previous courses significantly influences learners' achievements.

On the post-test (see Table 4.3), the gap narrowed from 12.00 to 9.00 which can be attributed to the use of LCA in the affirming learners' prior knowledge, hence equally moving learners along the continuum of learning. This is also in line with Kolb's theory of experiential learning' which states that "Learning is the process whereby knowledge is created through transformation of experience" (Kolb, 1984, p.38). Learners performed well in the post-test as a result of the conditions to which they were exposed during the LCA, enabling them to learn better.

2. **What are the differences in learners' performance in acids and bases in both schools?**

According to Tables 4.3 and 4.4 there was a difference in the performance of the two groups in the mean scores, the median, standard deviation, range and sum. The control group average mean of the two tests (11.2000+ 11.2000 = 22.4000/2 = 11.2000) and experimental group average mean of the two tests (11.9250+ 16.5000= 28.425/ 2= 14.2125), while the existing difference in mean is (14.2145-11.200 = 3.0125) between the control and the experimental group tests. This shows that, the experimental group mean is 3.0125 higher than the control group mean giving a clear indication that the experimental learners performed better than the control group learners. This difference in performance was brought about by the use of LCA.

These findings corroborate several other research reports indicating that active learning-based teaching methods such as small-group discussions, experimentation, stimulations and outdoor activities are more effective than traditional methods (e.g., the lecture) in improving student academic performance (Cook & Hazelwood, 2002; Saville, Zinn, & Ferreri, 2006). The findings of this study also agree with those of Martins and Oyebanji (2000) and Bajah and Asim (2002), who found that the guided discovery approach was more effective than the conventional or other methods of students' acquisition of knowledge in teaching-learning process.

Table 4.5 compared the pre-tests of both the experimental and control groups. The results indicated no significant difference in the pre-test scores between the experimental and the control group". Such results reflect those of Goodwin (1996), for whom, "the two comparable groups were intact classes with similar characteristics and all had the same level of understanding at the beginning of the study" (p.145).

On the other hand, Table 4.6, which compared the post-tests of both the experimental and control groups, showed that "There is a significant difference in the performance of the learners, when taught using a learner-centred approach".

3. How effective are the LCA methods in learning acids and bases?

The effectiveness of Learner-centred approach generally in the whole study was determined on the bases of teaching methods used, the course materials provided, as well as the outcome of the experimental group test scores in comparison with the control group test scores.

The results on teaching methods with reference to Figure 4.1 indicated that whilst the majority of the participants (81.3%) *strongly agreed* that small-group discussions were helpful, 11.3% were *neutral* while the rest, 6.3%, *disagreed*.

Bennett, Lubben, Horgarth and Campell's (2004) systematic review of the role of small-group discussions in science teaching revealed that the use of small-group discussions supported by a specific program fostering collaborative reasoning, including evaluating and strengthening of knowledge claims, improved learners' metacognitive knowledge of collaborative reasoning, including their knowledge of reasoning about evidence. In this study, the learners' performances improved after they were involved in small group discussions which improved their metacognitive knowledge of collaborative reasoning and knowledge of reasoning about evidence.

Another teaching method used was laboratory practical sessions and experimentation. The findings revealed that 91.3% of the participants were supporting experimentation and demonstrations, confirming Katz (1990) findings on the importance of an experimentation method of teaching which according to this author usually helps the learners to make a discovery, test a theory or demonstrate a factual claim by undertaking a scientific procedure. This method of teaching can help learners to try out new ideas practically, thus, gaining a better insight into the learning content (Katz, 1990).

The results on course materials (Figure 4.2) revealed that the majority of the participants (above 90%) indicated that the notes used as well as the activities given in the course were very useful and relevant to the topic of acids and bases, hence improving their performance on the topic. These findings confirmed research and anecdotal evidence from, Florida (USA), which overwhelmingly supported the claim that students learn best when they engage with relevant course materials and actively participate in their learning (Smit & Mathias, 2011).

Finally, the results on whether active learning has increased learners' interest in acids and bases (Figure 4.3) revealed that 97.7% of the participants *agreed* or *strongly agreed* that active learning had increased their interest in acids and bases. These results also confirmed a study by Minhas, Gosh and Swanzyl (2011) on the effects of active learning in a science lecture hall on students' attitudes and achievement, which argued that one positive affect that active learning can have on students is to increase their attitudes towards science. The findings have also been seen in past research from Johnson (2011), who reported learners' positive attitudes towards inquiry in the science classroom.

4.7 SUMMARY

This chapter presented the data on the effectiveness of learner-centred approach in learning acids and bases. It indicated that using learner-centred approach in learning acids and bases helps in understanding the topic and hence enhanced learners' performance in the post-test scores. Furthermore, it also indicated that, using different teaching strategies such as small-group discussions, laboratory experiments and demonstrations, as well as relevant course materials to test their understanding and evaluating active learning versus their progress, increases their interest in learning acids and bases.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary, conclusions and recommendations based on the findings and of this study. The possible areas for further research are also identified. This study investigated the effectiveness of learner-centred approach in learning acids and bases.

5.1 SUMMARY

The purpose of this study was to investigate the effectiveness of learner-centred approach in learning acids and bases at two selected secondary schools in the Ohangwena educational region. The study further discovered how the use of learner-centred approach affect learners' performance, and attempted to explore the differences in the performance of learners in learning the topics, acids and bases at both selected schools.

The study sought answers to the following research questions and hypotheses:

The main research question was:

> How effective is the learner-centred approach in the teaching and learning of acid and bases at a selected secondary school in Ohangwena region?

In order to fully address this research question, it was further divided into the following sub-questions:

> How does the use of learner-centred approach affect the Grade 11learners performance in learning Acids and Bases at a selected secondary school in the Ohangwena region?
>
> What are the differences in performance of the Grade 11 learners in both schools?

Hypotheses:

H_0 – There is no significant difference in learners' performance in acids and bases topics when taught using the learner-centred approach.

H_1 – There is a significant difference in learners' performance in acids and bases topics when taught using the learner-centred approach.

In order to assess how the Learner-Centred Approach (LCA) affects learners' performance a pre-test as well as a post-test were used in the experimental group before and after using the LCA in teaching acids and bases. The results shows an improvement in the performance of the experimental group learners' post-test. The results of pre and post-tests were analysed using descriptive statistics to determine the mean scores, median, standard deviation, range and sum, and these indicated an improved performance following the learner-centred approach used to teach in the experiment.

Finally, in order to determine the learners' views on the effectiveness of learner-centred methods used in the study closed-ended questionnaires were used as well as the post-test results of the experimental and control group. The study found that LCA teaching methods were effective in learning acids and bases. That is, small-group discussions were 81.3% effective while field trips, practical's and experimentations were 91.3% effective. The post-test results of the experimental and control group were also paired and analysed using a t-test. They showed a significant difference in the performance of the learner when taught acids and bases using a learner-centred approach.

5.2 CONCLUSION

Based on the study findings, it can be concluded that the Learner-Centred Approach affects the performance of the grade 11 learners in a positive way; as the t-test results revealed a significant difference in the performance of the learners when they were taught using learner-centred approach. Hence, learner-centred approach improves the performance of learners in acids and bases. That is, the experimental group taught using learner-centred approach had significantly higher scores than the control group taught using the Teacher-Centred Approach. On the other hand, there was no significant difference on the performance of the control group learners when they were taught acids and bases using teacher-centred approach.

In this study, learner-centred approach was effective in teaching acids and bases, as it helped learners to learn better and enhance their performance in acids and bases than the teacher-centred approach.

5.3 RECOMMENDATIONS

The Learner-Centred Approach was found effective in learning acids and bases; hence, it is recommended that Physical Science teachers should make the teaching and learning of the topics of acids and bases more practical-based. This can be achieved through facilitation of small-group discussions, with discovery learning and collaborations encouraged, allowing learners to explore and discover knowledge on their own, as this enhances their performance.

It is further recommended that the Ministry of Education, Arts and Culture (MEAC) in Namibia should fully assist teachers through workshops and training programmes to fully implement and reinforce the use of learner-centred approach in all schools, thus fostering the performance of learners in all subjects.

It is finally recommended that the Physical Science Senior Education Officers in regions should facilitate workshops and fully train the teachers to enhance and reinforce the implementation of learner-centred approach in all schools, since its use fosters learners' performance.

5.4 POSSIBLE AREAS FOR FURTHER RESEARCH

The following are areas for possible future research:

The extent to which Physical science teachers plan and present lessons based on learner-centred methods of teaching and learning.

This study focused only on two selected secondary school in one educational region. A larger sample and more regions could be used in order to find out the effectiveness of leaner-centred approach in learning different topics of concern in Physical Science and other subjects.

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APPENDICES

Appendix A: PRE-TEST

TOPIC: ACIDS AND BASES

INSTRUCTIONS TO PARTICIPANTS:

CIRCLE THE CORRECT ANSWER. **PLEASE DO NOT WRITE YOUR NAME ON THE TEST PAPER.**

---

1. **The following is NOT a property of an acid**
    a. Turns the universal indicator blue
    b. Is corrosive
    c. Has a pH of 5
    d. Has a sour taste

---

2. **The following property is a property of a base**
    a. Turns a universal indicator purple
    b. It has a sour test
    c. It has a pH of 1
    d. It is a proton donor

---

3. **A base can be defined as**
    a. A proton donor
    b. A proton acceptor
    c. An acceptor of hydroxide ions
    d. An OH group donor

---

4. **An acid can be defined as …**
    a. A proton donor
    b. A proton acceptor
    c. An acceptor of hydroxide ions
    d. An OH group donor

---

5. **The scale that measures the acidity, neutrality and alkalinity is called…**
    a. Likert scale
    b. DH scale
    c. pH scale
    d. Hp scale

6. What could be the PH of a solution containing 0.1 mol/dm^3 of a weak acid

a. 1
b. 5
c. 8
d. 14

7. A strong acid has a pH of

a. 1
b. 5
c. 8
d. 14

8. What could be the PH of a solution containing 0.1mol/dm^3 of a strong base

a. 1
b. 5
c. 8
d. 14

9. Neutral solutions have a PH of

a. 1
b. 5
c. 7
d. 14

10. The acid change a blue litmus paper to

a. Remains blue
b. Orange
c. Red
d. Purple

11. Dilute Sulphuric acid reacts with a base such as Sodium hydroxide. What word is used to describe this type of a reaction?

a. Combustion reaction
b. Reduction/oxidizing reaction
c. Neutralization reaction
d. Oxidizing reaction

12. What products are formed when any acid reacts with a base?

a. Salt and carbon dioxide
b. Salt and hydrogen
c. Salt and water
d. Salt and oxygen

---

13. What products are formed when an acid reacts with metals?

a. Salt and hydrogen
b. Salt and water
c. Salt and carbon dioxide
d. Salt and oxygen

---

14. What products are formed when acids reacts with carbonates?

a. Salt, water and hydrogen
b. Salt, oxygen and water
c. Salt, hydrogen and carbon dioxide
d. Salt, water and carbon dioxide

---

15. A solution is a concentrated acid when…

a. It has more hydroxide ions (OH^-) in a solution than the water molecules
b. It has less hydroxide ions (OH^-) in a solution than the water molecules
c. It has more hydrogen ions (H^+) in a solution than the water molecules
d. It has less hydrogen ions (H^+) in a solution than in the water molecules

---

16. A solution is a diluted acid when…

a. It has less hydrogen ions (H^+) in a solution than the water molecules
b. It has less hydroxide ions (OH^-) in a solution than the water molecules
c. It has more hydrogen ions (H^+) in a solution than the water molecules
d. It has more hydroxide ions OH^-) in a solution than the water molecules

---

17. Which is the correct set of acid properties as described by Boyle

a. Sour taste, corrosive, change a blue litmus paper to red
b. Sour taste, corrosive, change a red litmus paper to blue
c. Bitter taste, slippery, change a blue litmus paper to red
d. Bitter taste, slippery, change a red litmus paper to blue

---

18. Which of the following household products could have a pH =12

a. Soda pop
b. Tap water
c. Lemon juice

d. Oven cleaner

---

19. What ion do bases produce in solutions?

a. H^+
b. H^-
c. OH^+
d. OH^-

---

20. Vinegar, fruit juice, cola are examples of

a. Strong acids
b. Strong bases
c. Weak acids
d. Weak bases

!!!!!!!!!!!!Thank you for your participation!!!!!!!!!!!!!!!!!!!!!

Appendix B: **POST –TEST**

TOPIC: ACIDS AND BASES

INSTRUCTIONS TO PARTICIPANTS:

CIRCLE THE CORRECT ANSWER. **PLEASE DO NOT WRITE YOUR NAME ON THE TEST PAPER.**

---

21. The following property is a property of a base

e. Turns a universal indicator purple
f. It has a sour test
g. It has a pH of 1
h. It is a proton donor

---

22. The following is NOT a property of an acid

e. Turns the universal indicator blue
f. Is corrosive
g. Has a pH of 5
h. Has a sour taste

---

23. The scale that measures the acidity, neutrality and alkalinity is called…

e. Likert scale
f. DH scale
g. pH scale
h. Hp scale

---

24. An acid can be defined as …

e. A proton donor
f. A proton acceptor
g. An acceptor of hydroxide ions
h. An OH group donor

---

25. A base can be defined as

e. A proton donor
f. A proton acceptor
g. An acceptor of hydroxide ions
h. An OH group donor

---

26. An acid change a blue litmus paper to

e. Remains blue
f. Orange
g. Red
h. Purple

---

27. A strong acid has a pH of

e. 1
f. 5
g. 8
h. 14

---

28. What could be the PH of a solution containing 0.1mol/dm^3 of a strong base

e. 1
f. 5
g. 8
h. 14

---

29. Neutral solutions have a PH of

e. 1
f. 5
g. 7
h. 14

---

30. Vinegar, fruit juice, cola are examples of

e. Strong acids
f. Strong bases
g. Weak acids
h. Weak bases

---

31. Which of the following household products could have a pH =12

e. Soda pop
f. Tap water
g. Lemon juice
h. Oven cleaner

---

32. What products are formed when acids reacts with carbonates?

e. Salt, water and hydrogen
f. Salt, oxygen and water
g. Salt, hydrogen and carbon dioxide

h. Salt, water and carbon dioxide

33. Dilute Sulphuric acid reacts with a base such as Sodium hydroxide. What word is used to describe this type of a reaction?

e. Combustion reaction
f. Reduction/oxidizing reaction
g. Neutralization reaction
h. Oxidizing reaction

34. Which is the correct set of acid properties as described by Boyle

e. Sour taste, corrosive, change a blue litmus paper to red
f. Sour taste, corrosive, change a red litmus paper to blue
g. Bitter taste, slippery, change a blue litmus paper to red
h. Bitter taste, slippery, change a red litmus paper to blue

35. What products are formed when any acid reacts with a base?

e. Salt and carbon dioxide
f. Salt and hydrogen
g. Salt and water
h. Salt and oxygen

36. What products are formed when an acid reacts with metals?

e. Salt and hydrogen
f. Salt and water
g. Salt and carbon dioxide
h. Salt and oxygen

37. A solution is a concentrated acid when…

e. It has more hydroxide ions (OH^-) in a solution than the water molecules
f. It has less hydroxide ions (OH^-) in a solution than the water molecules
g. It has more hydrogen ions (H^+) in a solution than the water molecules
h. It has less hydrogen ions (H^+) in a solution than in the water molecules

38. A solution is a diluted acid when…

e. It has less hydrogen ions (H^+) in a solution than the water molecules
f. It has less hydroxide ions (OH^-) in a solution than the water molecules
g. It has more hydrogen ions (H^+) in a solution than the water molecules
h. It has more hydroxide ions OH^-) in a solution than the water molecules

39. What could be the PH of a solution containing 0.1 mol/dm^3 of a weak acid

e. 1

f. 5

g. 8

h. 14

---

40. What ion do bases produce in solutions?

e. H^+
f. H^-
g. OH^+
h. OH^-

!!!!!!!!!!!!Thank you for your participation!!!!!!!!!!!!!!!!!!!!!

APPENDIX C: **Questionnaire**

Instructions to participants:

- **Do not write your name on this form**
- **For each number, Mark with a cross (X) in the box of your choice**

Background information:

1. **Gender** **Female** ☐ **Male** ☐
2. **Age group** **16-20** ☐ **21-23** ☐ **Above 23** ☐
3. **Ethnic group** **Aawambo** ☐
   San ☐
4. **Geographical Location** **Semi-urban** ☐
   Rural ☐

Part 1: Teaching methods/strategies/practices

1. The lesson objectives were clearly explained at the beginning of the lesson.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. The difficult concepts were clearly explained

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. The areas of confusion were addressed clearly.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. Small- group discussions helped me to enhance my learning.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. Questions, comments and collaborations with other learners in the lesson were encouraged.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

PART 2: Evaluation of course materials (resources, assignments, assessments)

1. The activities in this course have enhanced my learning.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. The tests accurately assess what I have learned in this course.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. The notes are excellent for achievement in this class.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. The Laboratory experiments and demonstrations carried out were very useful and enhanced my learning.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

. 5. The feedback I have received on my work has enhanced my learning.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

PART 3: STUDENT LEARNING/AFFECT

1. I have learned a lot in this class, and these lessons improved my performance in acids and bases.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. This class has increased my interest in learning acids and bases.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. This lessons were very useful and have been effective in advancing my learning.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

!!!!!!!!!!!!!!!!!!!!!!Thank you for your participation!!!!!!!!!!!!!!!!!!!!!!!

Appendix D: Ethical Clearance Letter from the Research and Publication Office

UNAM
UNIVERSITY OF NAMIBIA

STUDENT ETHICAL CLEARANCE CERTIFICATE

Ethical Clearance Reference Number: FOE/64/2015 **Date: 10 November, 2015**

This Ethical Clearance Certificate is issued by the University of Namibia Research Ethics Committee (UREC) in accordance with the University of Namibia's Research Ethics Policy and Guidelines. Ethical approval is given in respect of undertakings contained in the Research Project outlined below. This Certificate is issued on the recommendations of the ethical evaluation done by the Faculty/Centre/Campus Research & Publications Committee sitting with the Postgraduate Studies Committee.

Title of Project: THE EFFECTIVENESS OF LEARNER-CENTRED APPROACH IN LEARNING ACIDS AND BASES IN TWO SELECTED SECONDARY SCHOOLS IN OHANGWENA REGION, NAMIBIA

Nature/Level of Project: Masters

Principal Researcher: S.I.T. Mutilifa

Student Number : 200713248

Host Department & Faculty: Faculty of Education

Supervisor: Dr. H. Kapenda

Take note of the following:

(a) Any significant changes in the conditions or undertakings outlined in the approved Proposal must be communicated to the UREC. An application to make amendments may be necessary.
(b) Any breaches of ethical undertakings or practices that have an impact on ethical conduct of the research must be reported to the UREC.
(c) The Principal Researcher must report issues of ethical compliance to the UREC (through the Chairperson of the Faculty/Centre/Campus Research & Publications Committee) at the end of the Project or as may be requested by UREC.
(d) The UREC retains the right to:
   (i). withdraw or amend this Ethical Clearance if any unethical practices (as outlined in the Research Ethics Policy) have been detected or suspected,
   (ii). request for an ethical compliance report at any point during the course of the research.

UREC wishes you the best in your research.

Prof. I. Mapaure
UNAM Research Coordinator
ON BEHALF OF UREC

Appendix E: Permission Letter from the Permanent Secretary (MoEAC)

REPUBLIC OF NAMIBIA

MINISTRY OF EDUCATION, ARTS AND CULTURE

Tel: +264 61 -2933200
Fax: +264 61- 2933922
Enquiries: C. Muchila
Email: Cavin.Muchila@moe.gov.na

Luther Street, Govt. Office Park
Private Bag 13186
Windhoek
Namibia

File no: 11/1/1

Ms Sanio I. T. Mutilifa
Cell: +264814494449

Dear Ms Mutilifa

SUBJECT: PERMISSION TO CONDUCT RESEARCH IN OHANGWENA REGION

Kindly be informed that permission to conduct research for your Master's Degree in Ohangwena region is herewith granted. You are further requested to present the letter of approval to the Regional Director to ensure that research ethics are adhered to and disruption of curriculum delivery is avoided.

Furthermore, we humbly request you to share your research finds with the ministry. You may contact Mr C. Muchila at the Directorate: Programmes and Quality Assurance (PQA) for provision of summary of your research findings.

I wish you the best in conducting your research and I look forward to hearing from you soon.

Sincerely yours

SANET L. STEENKAMP
PERMANENT SECRETARY

19. 01. 16
Date

All official correspondences must be addressed to the Permanent Secretary

Appendix F: Consent Form for Parents

I ………………………, the parent of ………………………, a grade 11 learner at a selected secondary school hereby give consent for my child to be a subject in the study entitled " *Investigating the effectiveness of learner-centred approach in learning acids and bases in two selected secondary schools"* by attending the afternoon sessions, sit for the tests and complete the questionnaires.

I understand that:

- My child is under no obligation to participate, and may withdraw from the study at any point prior to the publication or presentation of the research results.
- Anonymity will be maintained through the use of pseudonyms. The name of my child will not be reported.
- The research will be used for academic and professional presentations and publications.

……………………………………..   ………………………….

Signature   Date

Appendix G: Permission from the Director of Education, Ohangwena

OHANGWENA REGIONAL COUNCIL
DIRECTORATE OF EDUCATION
DIRECTOR'S OFFICE

1st Floor Greenwell Complex Private Bag 88005 Eenhana Tel: 065 – 290 201 Fax: 065 -290 224

Enquiries: Magano Gaoses
Email: mcnotto@yahoo.com

9 March 2016

Ms. Sanio I.T Mutilifa
P.O Box 333
Ongha

Subject: Permission to do research at Ongha SS and Eenhana SS.

1. Receipt of your letter on the above subject matter is hereby acknowledged.
2. Permission is granted for you to carry out the research on "The effectiveness of learner centered approach in learning acids and bases".
3. This is indeed regarded as a crucial research study as it may bring improvement in the teaching of science as you have indicated that a number of schools in our region has performed below average in the said subject.
4. This office has no objection in you carrying out your research and therefore would like to congratulate you on embarking on this important mission.
5. Please liaise with the Principals of the selected schools, and your presence at the school should be as well noted by the office of the Inspector of Education in those circuits.

Yours Sincerely,

10/03/2016

Ohangwena Regional Council
Directorate Of Education Arts and Culture
10 MAR 2016
REPUBLIC OF NAMIBIA

Isak Hamatwi
Director:MEAC
Ohangwena Region

CC: IoEAC – Ongha and Eenhana Circuits
Principal – Ongha SS & Eenhana SS

Appendix H: Lessons

Lesson 1: Acids and Bases **Teacher:** Ms. Sanio. Mutilifa
Grade 11……

Duration: 1hr 30 minutes **Date:** …………..

Learning Outcomes:

- Describe the characteristic properties of acids and bases
- Define acids in terms of proton transfer
- Define bases in terms of proton transfer

Introduction / Motivation

To introduce acids and bases, the teacher will instruct learners to conduct the following hands on activity.

With the Students

1. Ask students to suggest definitions of the following terms: pH, acid, base (alkaline) and neutral.
2. Ask them to consider where they may have heard these terms before. (Possible responses: Testing the pool/hot tub/aquarium, pH-balanced shampoo, deodorants, scrapbooking, hydrochloric acid in the stomach, saliva neutral PH, intestines with alkaline PH, soil PH etc.)
3. Tell students that they interact with acids and bases every day.
4. Distribute the food samples to students
5. Ask the students to sample each item. Have them rank the foods in order of which tasted the least bitter (sour) to the most bitter (sour). This step can be done formally on paper or more informally as a class.
6. After they rank the items, ask them to group the foods based on characteristics of taste.
7. Write the pH for each test item on the chalkboard (see Table 1).

Table 1: The pH values for test items

Food item	**PH**
Lemon	2
Water	7
Milk	6.5
Vinegar	2
Orange juice	4
Washing powder	8
Eno	9

Presentation:

8. Explain the general idea of a pH scale to the students. The pH scale ranges between 0 and 14, with 7 being neutral. Mention that acids have a pH of less than 7 and bases have a pH of greater than 7.

9. Do the groups that the students suggested agree with this new information? Can they come up with some common touch (feel) and taste descriptions of acids and bases? (Rule of thumb: Acids are bitter, bases are often sour.) Table 2.

	Acids	**Bases**
Taste	Sour taste	Bitter taste
Feel	Have a rough feel	Have a slippery feel
Effects on litmus paper	Turns a blue litmus paper red	Turns a red litmus paper blue
Reactions	• Reacts with metals to form salt & Hydrogen gas • Reacts with bases to form Salt & water • Reacts with carbonates to form salt, water and Carbon dioxide	• Reacts with acids to form salt and water
Examples:	Vinegar, citrus fruits, apples, soda, milk etc.	Baking soda, ammonia, washing powder , Eno etc

Lesson Background

All substances are divided into three categories — **acids, bases** and **neutral** substances. Acids and bases are some of the most important substances on Earth. There are strong and weak acids and bases, and their strengths are described by the pH scale.

List at least three characteristic properties of acids and three of bases.

 ACIDS

pH less than 7

Have a sour taste

Change the color of many indicators

Are corrosive (react with metals and carbonates and bases)

Neutralize bases

Give H^+ Ions in solutions

Conduct an electric current

- **BASES**

pH greater than 7

Have a bitter taste

Change the color of many indicators

Have a slippery feeling

Reacts with fats, oils and acids

Neutralize acids

Give OH^-ions in solutions

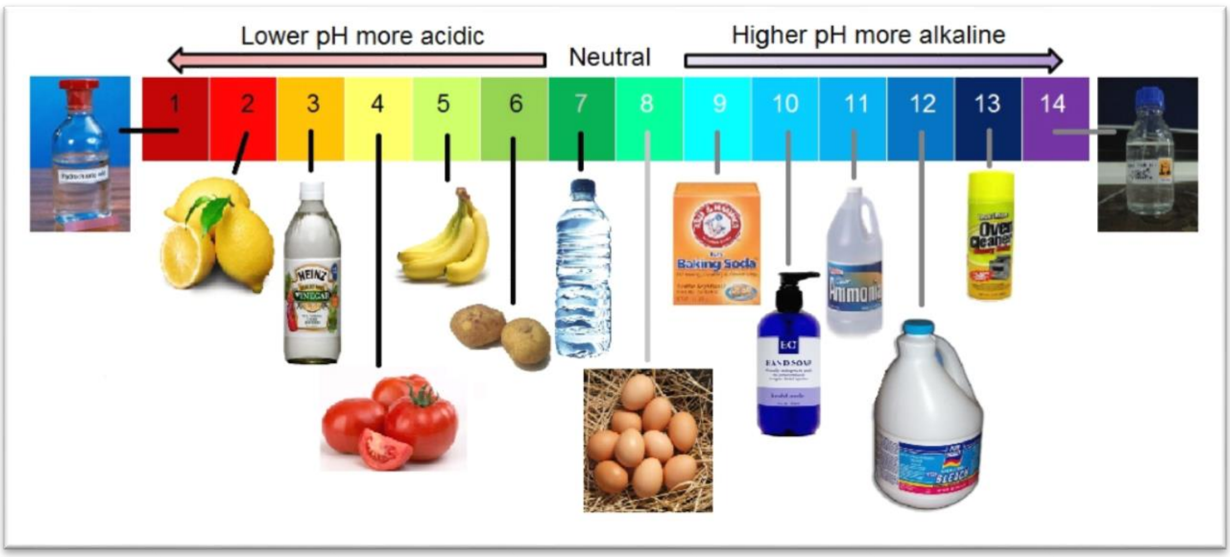
Conduct an electric current

The theory that define acids and bases:

The **Bronsted-Lowery theory** states that acids donate protons and bases accept protons.

The pH Scale

The **pH** scale is used to describe the hydrogen-ion (H^+) concentration of an aqueous solution. The pH scale ranges between 0 and 14, with 7 being neutral. A solution with a pH below 7 is acidic, and a solution with a pH greater than 7 is basic (alkaline). Each one-unit change in pH is a tenfold increase (or decrease) in the strength of the acid or base. A change from pH 5 to pH 3 increases in acidity.



Indicators

Indicators are tools used to measure/indicate the pH of a substance. A color change in the indicator corresponds to different pH levels.

Litmus paper is frequently used to investigate the pH of different substances. Litmus paper is infused with litmus, a water-soluble blue powder derived from certain lichens (a type of fungus). The paper color changes depending on the pH of the substance with which it is in contact. The more basic a substance, the bluer the indicator turns. The more acid the substance, the redder the paper turns.

Vocabulary

Acid: A substance whose pH is less than 7.

Alkaline: Another term for a base.

Base: A substance whose pH is greater than 7.

Bronsted-Lowery theory: States that acids donate protons and bases accept protons.

Indicator: A tool used to measure/indicate the pH of a substance. A color change in the indicator corresponds to different pH levels.

Litmus paper: An acid-base indicator made of paper infused with litmus (a water-soluble blue powder derived from certain lichens, a type of fungus) whose color changes depending on the pH of the substance with which it is in contact. There are type specific papers and wide range papers available.

Neutral: A substance with a pH of 7.

pH: A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale is used to describe the hydrogen ion (H+) concentration of an aqueous solution. [p(otential of) H(ydrogen)].

Reinforcement: teacher to recap the main points of the lesson. Characteritics of acids and bases, as well as definitions of acids and bases in terms of proto transfer.

Homework: Activity

NAME ____________

DATE ________ PERIOD ____

Acids vs. Bases Worksheet

	Acids	Bases
How do they feel?		
How do they taste?		
What types of chemicals do they react with?		
What ion do they produce in solution?		
What is the result of testing with litmus paper?		
Give 2 examples (name or formula) of common **household** products		
What is their pH range?		

Identify the following as an acid, a base, or neutral.

KBr________________ LiOH________________ H_2S________________

H_3PO_4________________ $CaCl_2$________________ $Ba(OH)_2$________________

Why shouldn't you taste or touch acids and bases in the chemistry lab?

List one **industrial** use of acids.

Lesson 2: Acids and Bases **Teacher:** Ms. Sanio. Mutilifa

Grade 11……

Duration: 1hr 30minutes **Date:** …………..

Learning Outcomes:

- Describe neutrality and relative acidity and alkalinity in terms of pH (whole numbers only), measured using Universal Indicator paper
- Explain the difference between weak/strong acids and concentrated/dilute acids

---

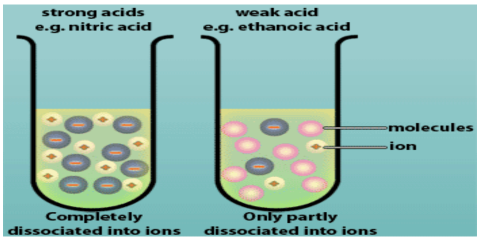
Introduction and Motivation

- Recap pH with learners as it was done in lesson 1
- Ask question on pH(Alkalinity, acidicity and neutrality)
- Explain the strong/weak acids as well as concentrated and diluted acids

---

Strong Acids and Bases

Strong acids dissociate completely into **ions** in solution and give a low **pH**. Weak acids only partly dissociate into ions giving a higher pH



Strong bases: **Strong Acids**

LiOH	lithium hydroxide
NaOH	sodium hydroxide
KOH	potassium hydroxide
RbOH	rubidium hydroxide
CsOH	cesium hydroxide
*$Ca(OH)_2$	calcium hydroxide
*$Sr(OH)_2$	strontium hydroxide

*$Ba(OH)_2$	barium hydroxide
HCl	hydrochloric acid
HNO_3	nitric acid
H_2SO_4	sulfuric acid
HBr	hydrobromic acid
HI	hydroiodic acid
$HClO_4$	perchloric acid

Ethanoic acid (vinegar) CH_3COOH

Carbonic acid (soda water) H_2CO_3

Sulphurous acid (acid rain) H_2SO_3

Concentrated and Diluted Acids

- A diluted acid has a high percentage of water molecules and a small percentage of the acid particles.

While

- A concentrated acid has a high percentage of the acid particles and a small percentage of water molecules.

Handy on activity:

1. **Dissolve the following reagents and determine whether they are strong or weak acids as well as the pH of their solutions.**

Acid	Weak /Strong	pH
Ethanoic acid		
Phosphoric acid		
Nitric acid		
Carbonic acid		
Hydrochloric acid		

Duration: 1hr 30 minutes **Date:** …………..

Learning Outcomes:

- Describe acids by their reactions with metals, bases and carbonates
- Use these ideas to explain specified reactions as acid/base (Neutarlization reaction)
- Explain difference between alkalis and bases

Introduction & Motivation

- Teacher to recap the definitions of acids, bases and pH. as well as weak/strong and concentrated and diluted acids with learners.
- Teacher to introduce the reactions of acids and bases by highlighting the reactions of acids with metals, acids with Bases and acids with Carbonates and give an opportunity to learners to react the reagents provided for each set of reactions.
- Teacher to differentiate between alkalis and bases.

Reactions of acids with bases

When acids and bases react with each other, they can form a salt and (usually) water. This is called a **neutralization reaction** and takes the following form:

$HA + BOH \rightarrow BA + H_2O$

- Acids release H^+ into solution and bases release OH^-. If we were to mix an acid and base together, the H^+ ion would combine with the OH^- ion to make the molecule H_2O, or plain water:

$$H^+(aq) + OH^-(aq) \rightarrow H_2O$$

Strong acid + strong base ⟶ **Salt + Water**

- e.g $HCl + NaOH \rightarrow NaCl + H_2O$
    - When strong acids and strong bases react, the products are salt and water. The acid and base neutralize each other, so the solution will be neutral (pH=7) and the ions that are formed will not reaction with the water.

Handy on activities: carry out the following reactions and fill in the products formed:

Acid	Base	Salt	Water

HCl	+	NaOH	→	....	+	....
HBr	+	KOH	→	....	+	....

Part 1: Reactions of acids with metals

Active metals react with acids to produce hydrogen gas and a salt.

The general equation of this type of chemical reaction is

Active metal + acid ⟶salt + hydrogen gas

This is an example of a **single displacement reaction.** One element (the active metal) displaces another in a compound (the acid). Active metals displace the hydrogen from acids producing hydrogen gas.

The two most common acids used are hydrochloric acid, HCl and sulfuric acid, H_2SO_4

Example.

Magnesium + sulfuric acid ⟶magnesium sulfate + hydrogen

$Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$

The magnesium displaces the hydrogen from the acid. It's like calling for a single substitution during a game of basketball. Mg goes on the court and H_2 comes off.

Handy on Activity: Carry out the following reactions and fill in the products formed:

1. Zinc + sulfuric acid ⟶ .... +..............................

$Zn + H_2SO_4 \longrightarrow$.. + ...

2. Magnesium + hydrochloric acid ⟶ ....+ ....

Mg + 2HCl ⟶...+ ....

3. Iron + sulfuric acid ⟶ .... + ...

$Fe + H_2SO_4 \longrightarrow$ .... + ...

Part2: Reactions of Acids with carbonates

What is a carbonate?

.**Carbonates** are compounds that contain the **CO_3 group.**

.Sodium hydrogen carbonate also called bi-carb of soda or baking soda is a common household carbonate. Its chemical formula is $NaHCO_3$

Identify which chemical compounds contain the carbonate group

No.	Chemical	Carbonate? Yes/No
1.	Na_2SO_4 sodium sulfate	
2.	Na_2CO_3 sodium carbonate	
3.	$NaNO_3$ sodium nitrate	
4.	$CuSO_4$ copper sulfate	
5.	$CuCO_3$ copper carbonate	
6.	$CaCO_3$ calcium carbonate	
7.	$Ca(NO_3)_2$ calcium nitrate	
8.	$PbSO_4$ lead sulfate	
9.	$MgCO_3$ magnesium carbonate	
10.	SiC silicon carbide	

Key point:

- Compounds with a carbonate or **CO_3 group** react with acids to produce carbon dioxide, **CO_2 gas.**

General word equation

Acid + Metal carbonate $\longrightarrow$ Salt + Water + Carbon dioxide

All carbonates react with acids to produce salt, water and carbon dioxide gas.

The fizz produced in sherbet is a reaction between a food acid and a carbonate.

The ingredients dissolve in your mouth and react with each other producing the carbon dioxide fizz.

Examples of acid and carbonate reactions

1. Hydrochloric acid + sodium carbonate ⟶ sodium chloride + water + carbon dioxide

$2HCl + Na_2CO_3 \longrightarrow 2NaCl + H_2O + CO_2$

Handy on Activity: Carry out the following reactions and fill in the products formed:

2. Sulfuric acid + copper carbonate ⟶ ....+ .... + ...

$H_2SO_4 + CuCO_3 \longrightarrow$ .... +..................... +.........................

3. Nitric acid + magnesium carbonate ⟶ .... + ... + ...

$2HNO_3 + MgCO_3 \longrightarrow$ .... +.......................... +................................

4. Acetic acid + sodium hydrogen carbonate ⟶ ....+ ....+............

$CH_3COOH + NaHCO_3 \longrightarrow$ ....+ ....+..............................

References:

http://chemistry.about.com/od/acidsbases/a/aa110204a.htm

http://www.chemicalformula.org/reactions/acid-carbonates

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