SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF CHEMISTRY

IDENTIFYING AND MINIMIZING STUDENTS' MISCONCEPTIONS IN CHEMICAL BONDING: THE CASE OF GRADE 9 STUDENTS IN KUTERE SECONDARY SCHOOL, SILTE ZONE,CENTRAL ETHIOPIA, ETHIOPIA

M.Sc. Thesis

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A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF WOLKITE UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN CHEMISTRY

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DECLARATION

I hereby declare that this M.Sc thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

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We here by certify that we have read and evaluated this thesis entitled “Identifying and minimizing students’ misconceptions in chemical bonding a case of grade 9 in Kutere Secondary School” prepared under our guidance by Mr Hassen Mahmud Ali we recommend that the thesis shall be submitted as fulfilling the requirements for the award of a M.Sc. Degree in Chemistry.

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As members of the board of examiners of Master of Science thesis open defense examination, we have read and evaluated this thesis prepared by Hassen Mahmud Ali and examined the candidate. We here by certify that, the thesis is accepted for fulfilling the thesis requirements for the award of the degree of Master of Science (MSc) in chemistry.

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Name of college of post graduate coordinator	Signature	Date
Office of school of graduate studies, Dean	Signature	Date

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LIST OF ABBREVIATIONS

CR	Correct Response
CR/T	The ratio of correct response to the total respondents
CUQ	Conceptual understanding Question
IQ	interview questions
n	Sample size of the study
N	Population of the study
N (con)	Sample size of control group
N(exp)	Sample size of experimental group
RQ	Research Question
WKU	Wolkite University
WR	Wrong Response
WR/T	The ratio of wrong response to the total respondents

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ABSTRACT

Children do not come to school as a “tabula rasa, but rather with knowledge gained from different sources and through daily life. These different sources can help or hinder learning. This situation is said to be misconception. The main purpose of this study was to identify and minimize students’ misconceptions about chemical bonding. The study was carried out in Kutere Secondary School in Silte Zone, Central Ethiopia with special reference to grade 9 students’ focus. Descriptive survey, especially a case study was employed to address the problem. To conduct this study 72 students were selected through stratified sampling technique from the total population of 360 students. To achieve the objectives of the study employed data gathering tools were the conceptual understanding tests (pre-and post-test) in the chemical bonding topic. Each question in the conceptual understanding test was designed to previous students’ knowledge and understanding about chemical bonding. All data collected were analyzed quantitatively. The study described the causes for these misconceptions. These were students’ personal experience, inappropriate use of laboratory, misinformation, inattentiveness, selective attention, and unevaluated text books. Replacing those misconceptions with scientifically accepted conceptual views is necessary and efforts should be made to create awareness continuously for students, teachers, school principals and educational experts. Conducting training and different workshop with those concerned bodies is more advisable to increase the understanding and to avoid (minimize) misconceptions in chemical bonding. Thus, to improve the situation, it is recommended that every educator should be aware of students background, daily life experience, pre conceptions before providing lessons on chemistry teachers should spend more time to produce more conceptual talk about the topic to bring conceptual understanding, different instructional methods should be applied to support conceptual understanding of chemical bonding.

Key words: Chemical bonding, Misconceptions, Secondary School.

CHAPTER ONE

1.1 INTRODUCTION

It is well known that during the learning process, students construct new knowledge from their previous ideas, skills and experience. Sometimes the students' ideas are not consistent with scientific conceptions and then misconceptions, alternative frameworks or preconceptions account. All of them negatively affect the teaching-learning and make difficult to build new concepts consistent with the accepted scientific ideas. Therefore, it is highly important to precisely know them for an effective teaching methodology [1].

Education helps human beings to improve, change as well as develops and conserves his/her environment for an all-rounded development by diffusing science and technology into society. This cannot be achieved without science. Therefore, it is necessary for our students from the very beginning of their study to be on the right track of scientific conceptions. There are so many different sources for students to build up their scientific conceptions such as student's personal experience, peer interaction, media and language, symbolic representation (example, equations, graphs, textbooks, and laboratory works). Many research studies have shown that, these sources sometimes produce wrong representation of scientific concepts. Children do not come to school as a "tabula rasa" or they do not come into class as blank slates, but rather with knowledge gained from different sources and through daily life [2].

The students' prior knowledge can help or hinder learning. This knowledge consists of an amalgam of facts, concepts, models, perceptions, beliefs, values, and attitudes, some of which are accurate, complete, and appropriate for the context, some of which are inaccurate, insufficient, or simply inappropriate for the context. As students bring this knowledge to bear in our classrooms, it influences how they filter and interpret incoming information. Ideally, students build on a foundation of robust and accurate prior knowledge, forging links between previously acquired and new knowledge that help them construct increasingly complex and robust knowledge structures. However, students may not make connections to relevant prior knowledge spontaneously. If they do not draw on relevant prior knowledge in other words, if that knowledge is inactive, it may not facilitate the integration of new knowledge [3].

Moreover, if students' prior knowledge is insufficient for a task or learning situation, it may fail to support new knowledge, whereas if it is inappropriate for the context or inaccurate, it may actively distort or impede new learning [3].

According to constructivist models of learning, the process of learning involves the "building up" knowledge structures. Constructivist models of learning assume that existing knowledge and understanding are the basis for deeper and lasting learning. Theories of memory processing suggest that long-term retention of knowledge involves the consolidation of knowledge, through changes that increase the levels of integration of recent learning with well-established knowledge [4].

The role of students' pre-instructional conceptions that are not in accordance with scientific concepts has proven to be important in learning. If students do not understand concepts as scientists do, this situation is described as misconceptions by different researchers. Students' conceptions are surprisingly similar in different student age groups and adults and some teachers hold similar conceptions also educators need to worry about misconceptions for meaningful learning [5].

Learners start constructing knowledge with prior knowledge that they have before they enter the classroom. In addition, when they are introduced to an analogy, they have already created an idea of how it relates to the real situation. "We found that the reason the students had difficulty understanding some concepts, such as the concept of chemistry was because of their ontological presupposition of the concept. They use their existing knowledge of what they understand about the situation, make sense of concepts based on this understanding, and find it difficult to reassign that concept to another set of ideas. Therefore, if they have a particular understanding of how something works, they interpret any new knowledge in accordance with their pre-existing idea. However, it is important to find a link between the previous knowledge and the expected target. Student's preconceptions in science, particularly in chemistry have aroused science educators' interest because of the principle idea of constructivist learning theory, which was stated as "students come to the learning environment with the preconceptions, which were formed during their interactions within a physical and social environment and those preconceptions affect learning For about 20 years, the role of misconceptions in learning science has been investigated extensively" [6].

Numerous interviews with students at various levels have been conducted and it was found that misconceptions were frequent, the roots of misconceptions, how they affect learning of disciplinary knowledge, and how they can be remedied have been investigated by many researchers **[7]**. The term misconception refers to the ideas that students have about any phenomena that are inconsistent with scientific conceptions. The goal of effective science instruction is to encourage the student to construct an understanding that is generally consistent with accepted scientific theory. It is known that students use preexisting conceptions constructed from previous experiences to reason about newly presented science concepts. Such preconceptions are often incorrect from a scientific point of view and can interfere with students learning of science [8].Studies have been done in many parts of the world about students misconceptions on chemistry. Active areas of research about chemistry misconceptions are

topics of chemical bonding, but studies regarding misconceptions on the topic have not been reported repeatedly locally. Considering the above mentioned rationales, it was aimed to investigate ninth grade students' misconceptions about chemical bonding and to determine their related misconceptions. It is believed that for the coming studies on students' conceptual change about chemical bonding provide important benefits for chemistry teachers, curriculum developers and textbook writers [9].

1.2. Statement of the problem

The conceptual demand of chemistry has been established as a contribution to the difficulty of the subject. Other factors have jointly contributed to students' low achievement in the subject, with misconceptions as one of them. Therefore, urgent need to look for an appropriate, suitable, and effective instructional strategy to teach chemistry concepts for conceptual change. Some times in teaching-learning processes students do not understand the lesson's real and intended idea. This problem may arise from many sources such as the language usage of the teacher, the understanding level of students, and the difficulty of the lesson. The problem may face in many schools [10]. In the same way from researcher's observation in his day to day instructional activities, in Kutere secondary school, the problem that is the misconceptions in chemical bonding lesson is one of the problems.

Since the current researcher observed from the researcher day to day teaching-learning activities on the difficulties from chemistry topics; Students' misconception about chemical bonding concepts, low performance of students observed in Chemical bonding definition, formation of ionic bonding, covalent bonding and intermolecular forces, misconceptions of chemical bonding types such as ionic, covalent, coordinate covalent and metallic bonding.

1.3.Objectives of the study

1.3.1. General objective

The general objective of this study was to identify and minimize students' misconceptions in chemical bonding.

1.3.2. Specific objectives

The specific objectives of this study were:-

- To identify student's misconceptions on chemical bonding concepts
- To describe the misconceptions on chemical bonding concepts
- To find out the factors that make misconceptions on chemical bonding concepts
- To find solutions for the occurring misconceptions on chemical bonding concepts

1.4. Research questions

The research questions raised in this study are;

- What are grade 9 student's misconceptions on chemical bonding concept?
- What are other misconceptions on chemical bonding concepts within selected students?
- What are the causes of the misconceptions on chemical bonding concept?
- What are the solutions for the occurring factors on chemical bonding concept?

1.5. Significance of the study

The purpose of this study was investigating the existence of misconceptions on chemical bonding and how it can be corrected and recommending the impact of misconceptions in instructional process in order to support students on their conceptual understanding of chemical bonding.

The finding of this study was important for different concerned educational professionals that are found at various levels: For students, teachers, school administrators, and, the study also could be used as an additional source of information for further studies.

1.6.Delimitation of the study

This study covered only chemical bonding subjects in grade 9 in the case of Kutere Secondary School of Central Ethiopia, Silte Zone due to the existence of misconceptions on chemical bonding.

1.7.Limitation

The potential problem faced in the research process was the unwillingness of a few respondents to fill in the questionnaire (pre-test) and return on time, and the shortage of time to collect the data were the constraints encountered by researcher. However, the researcher appoints the respondents frequently and showing the commitment to complete this study successfully.

CHAPTER TWO

2. LITERATURE REVIEW

2.1.Concepts

Concepts can be regarded as ideas, objects or events that help us to understand the world around us [11]. Learning is the process of making connections between the new knowledge and the existing ones. In the learning process, students construct the new knowledge through their cognitive frameworks, abilities, values, and experiences [14].

Since students themselves construct the meanings of new knowledge in their minds, they may sometimes differ from the scientifically accepted ones. Students bring their ideas not consistent with scientifically accepted ones into their science class [15]. Students' ideas that are not consistent with scientific conceptions are called different terms such as misconceptions, preconceptions, alternative frameworks, children's science, spontaneous knowledge, preconceived notions, and factual misconceptions [16]. Although students' conceptions are not consistent with scientifically accepted ones, they are deeply settled down in students' cognitive structure since they are reasonable for them [17]. These non-scientific conceptions negatively affect students' further learning and hinder students from the new constructions which are consistent with scientifically accepted ideas [18]. Therefore, the first step for performing an effective concept teaching is to elicit students' preconceptions, some of which may differ from the scientific ones. As in the other sciences, it has been known that student misconceptions are also common in chemistry [19].

Chemistry courses commonly cover a great number of abstract concepts because chemistry generally deals with the inner structure of matter. As a consequence, it is more complicated and difficult for students to construct the meanings of chemistry concepts than those of the concepts in other natural sciences [20]**.**

Chemical phenomena or chemistry concepts are explained at three levels which are named as macroscopic, sub-microscopic, and symbolic. Macroscopic level includes the observable properties or events that students may encounter in their daily life. Sub-microscopic level includes the particles and their interactions such as atom, molecule, electron, reactions and chemical bonding which cannot be seen directly. Symbolic level represents the chemical processes in terms of formulas, equations, numbers, and signs. They are directly connected with each other, so that students' knowledge at each level has great importance to understand a chemical phenomenon clearly [21].

In the science education literature, not making the correct connections among three levels is referred as the most important reason of students' misconceptions about most chemistry subjects in the science education literature [22].

In the last two decades, a great number of studies have been conducted on students' understanding about different chemistry subjects [23]. They have elicited and reported various misconceptions of students at almost all grades ranging from primary school to universities. One of the most problematic contents on which students generally have misconceptions is acids, bases and chemical bonding. Understanding the contents of acids, bases and chemical bonding is crucial for students' further learning because it underlies of most of the advancing contents in chemistry lessons. It is necessary for students to construct the meanings of chemical bonding concepts properly to understand other chemistry subjects such as chemical reactions, chemical reactivity, structure of mater, change of state, physical and chemical change. However, chemical bonding concepts are abstract and far from students' daily experiences [25]. Therefore, most students have difficulties in understanding chemical bonding and have various misconceptions about it. There have been many studies reporting students' various misconceptions about acids, bases and chemical bonding and its types in the international science education literature developed a former diagnostic test to investigate students' misconceptions about covalent bonding [26].

This instrument was administered to 84 students of grade 10 from different secondary school. It was ensued that students commonly had misconceptions about chemical bonding investigated British students' understanding level about chemical bonding. The author aimed to determine how common the misconceptions which had been reported in the earlier studies were in a larger group of students [27]. He collected data through a questionnaire which was administered to the sample consisting of 370 students. Results of the study showed that a high percentage of students had misconceptions about the lattice structure of sodium chloride and how ionic bonding was formed [19]. Investigated 14- to 16-year-old Singaporean students' misconceptions on chemical bonding. Researchers developed and used a diagnostic instrument to collect data. The diagnostic test was administered to the sample consisting of 119 students. They found that students had some misconceptions about the formation of chemical bonding between atoms, lattice structure of compounds, the electric conductivity of graphite, intramolecular and intermolecular forces. A study carried out to bring out college students' misconceptions about the characteristics of the atoms which form different types of chemical bonding. He conducted individual interviews with 56 students to collect data [24].

Author found that students had misconceptions about atoms, molecules, and formation of chemical bonding, bond polarity, Lewis dot structures, polarity of molecules, and the types of chemical bonding. Moreover, it is found that the percentage of students who had misconceptions did not decrease considerably despite the

increasing level of education. There have been limited number of studies probing students' understanding and misconceptions on chemical bonding in Turkey, although a great number of studies, some of which are summarized above, have been conducted in many countries [28].Besides, all studies in Turkish science education literature have focused on students' understanding of all types of chemical bonding, namely on the whole concepts in the subject of chemical bonding, rather than focusing on that of a specific type of chemical bonding such as either ionic or covalent bonding. Moreover, all studies, in both Turkish and international science education literature, have rarely focused on the possible sources or reasons of these misconceptions [29].

The aim of chemistry education is not only to provide students all knowledge related to chemistry, but also to help them clearly understand the basic concepts and the connections among them. Therefore, teaching strategies which allow students to make correct scientific connections among concepts should be employed in chemistry education. The first step in this process is to elicit students' preconceptions and the connections which they established among the concepts Revealing students' misconceptions and their erroneous connections among the concepts makes major contributions to both chemistry teachers and curriculum developers. By this means, teachers could plan their teaching activities in such a manner that students could remedy their misconceptions and have scientific ideas about the phenomena. Moreover, curriculum developers could use students' misconceptions revealed from such studies to design learning environments in which effective concept teaching is performed, or to decide the instructional activities which should be taken place in these learning environments. Considering the abovementioned rationales, it was aimed to investigate eleventh grade students' understanding about covalent bonding and to determine their related misconceptions. It is believed that for the coming studies on students' conceptual change about chemical bonding provide important benefits for chemistry teachers, curriculum developers and textbook writers [9].

2.2. Misconceptions

Misconceptions can be described as incorrect ideas, mental models, or understandings that are based on personal experience. These incorrect ideas are a result of predictions that disagree with observations. Misconceptions have also been described as preconceived notions, on scientific beliefs, native theories, mixed conceptions, or conceptual misunderstandings [12]. Experiences do not always lead to the correct conclusions or learners do not always see all possible outcomes in terms of why and how certain occurrences take place. Parents and family members may not always give the correct answer when confronted with questions from their children. Other sources of misconceptions include analogies, the media, teacher explanations, and textbooks [13].

Studies show misconceptions amongst learners about chemical bonding [30]. These researchers may have used different terms or names to describe the misconceptions, but a common thread was found. A South African study shows that learners have preconceptions, for example, the pre-existing knowledge that they may have from different cultures, experiences, teaching and misconceptions which are created based on poorly understand pre-existing knowledge. Several studies were conducted to find common misconceptions in chemistry by learners [31].

2.3.Factors related to misconceptions

Many factors contribute to the formation of misconceptions amongst learners. Each factor that was found to be common in the literature is discussed below:

2.3.1. Gender and background

It is evident from literature that a vast amount of research has been done to identify misconceptions amongst learners. Through these studies, some researchers have found reasons as to how misconceptions are created associate gender with misconceptions. They explain in great detail of factors that could influence misconceptions in girls rather than in boys. The ins and outs of the school experiences of learner's play a strong role in their attitude towards science argues that if a learner is not enthusiastic about science, the possibility of constructing meaning and understanding from chemistry lessons is minimal. Girls usually tend to take interest in subjects other than science and this may influence the number of misconceptions in girls since girls may be treated differently at home, their back ground and interest in chemistry differs from that of boys. This inevitably will affect the way in which they develop and the knowledge that they may construct and will therefore impact on their knowledge in certain sections of chemistry [28].

"Alternative conceptions are held by individuals because of their diverse set of personal experiences including direct observation and perception, peer culture and language, teacher's explanations, and instructional materials" [32]. Learners' experiences outside of school will influence his or her performance inside school. External, social factors are known to affect learner performance amongst all learning areas. It is therefore, argued that the different experiences of girls influence their understanding and performance in science, who strongly agrees that boys have fewer misconceptions than girls as it was evident in his study where he compared the understanding of chemistry through samples of males and females at school and alsoat the university level. However, they are contradicted that gender does not play a major role in misconceptions in chemistry. It is, in fact common amongst both genders. There is no empirical evidence of why boys may perform better in science than girls [33].

2.3.2. Cognitive perspective

Age also plays a role in the creation of misconceptions. He views learners as being of different ages and different mental and physical stages. He also sees them as being at different maturity levels so the knowledge that they should construct when they are at a certain stage is not guaranteed and could be hindered by the phase that learners are in within their lives [34].

Piaget's theory of cognitive development explains the ability of learners as their "thinking processes change radically, though slowly, from birth to maturity because we constantly strive to make sense of the world. Piaget identified four factors; biological maturation, activity, social experience and equilibration that interact to influence changes in thinking". Piaget argues that children develop in stages, at the concrete operational stage (7-11 years) learners are not able to construct and make logical deductions [35].

They cannot transfer their knowledge well at this stage, cognitive development, as described is "gradual orderly changes by which mental processes become more complex and sophisticated", the difference in cognitive development is possibly responsible for differences in understanding, because learner's perceptions and ability to grasp concepts will differ [34].

2.3.3. Lack of knowledge

The lack of knowledge amongst learners was mistaken for misconceptions in many studies. All found that in many instances, a learner that actually does not have knowledge is thought of as having a misconception regarding the topic. Different learners are being taught by different teachers using different teaching methods at a primary level, and the learners already have a certain amount of prior knowledge [37].

There are three different problems; "discrepancy" "uncertainty", and "incompleteness". Discrepancy is the difference of what the learners understand and the teacher thinks the learner understands. Uncertainty is when the learner is in doubt his or her understanding of a concept. Incompleteness is when the learner has some knowledge and understanding but does not completely grasp the concept. Suggest methods to solve these problems; discrepancy which can be solved by revising the concept. Uncertainty is which can correct by assessing if the learner understands the concept correctly and "incompleteness" which can be corrected through remedial instruction using methods that are suitable for the learner to grasp the concepts [35].

2.4.Factors related to teaching chemistry

Teaching science is influenced a multitude of factors. In the section below, factors that may relate to the teaching of chemistry are discussed.

2.4.1. Teachers and their beliefs

The Experiences of teachers and their beliefs play an intricate part in the way they teach. This impacts the understanding and interpretation of learners [36]. Many teachers are resistant to change. They do not adopt their teaching methods to accommodate the type of learners that they have in terms of background, language, cognitive ability and so further found that teachers feel that advancing their studies will not help them to avoid learners' misconceptions [37]. Explanation for teachers not advancing their studies is "Science education is theoretical, impersonal and static with little relationship to the practical knowledge on the classroom required when giving the science lesson" [38].

2.4.2. Conceptual understanding

Teaching learners to understand how chemical bonding on a qualitative level is a difficult pedagogical challenge [39]. Concepts such as chemical bonding, which are the central concepts in chemistry, are very abstract by nature. Consequently, there is great difficulty in providing learners with accurate information about chemistry in a comprehensible format. Literatures explained that conceptual understanding through practical manipulation in real chemical bonding can be problematic, because learners can only observe what is happening at the surface level; however, they are unable to grasp underlying processes and mechanisms. Alternatively, learners are provided with an algebraic equation. Therefore, it is important to not only identify misconceptions, but also to understand "some reasons for their persistence," and "how a student's current ideas interact with new, incompatible ideas" [40]. For a learner to learn, there needs to be some form of dissatisfaction about the existing concept within the learner. The learner needs to find the new concept plausible, which is usually difficult for learners. If the new concept is plausible it must be intelligible. This requires, "an understanding of the component terms and symbols used and the syntax of the mode of expression''. The learner needs to find the new concept to be fruitful in a way that will "lead to new insights and discoveries". These are the four criteria needed for conceptual change and may be used by teachers to address their learners' misconceptions [41].

2.4.3. Analogies

An analogy is "a comparison between one thing and another, typically for explanation on clarification" [42]. Analogies are a method of learning and constructing knowledge about concepts that are difficult to understand. This method of teaching has been used for years and allows learners to create a picture in their mind of what may be occurring and the process that may be taking place. It allows for a visual perspective on a topic to allow for clearer and more in-depth understanding. Analogies are very popular in science teaching. The water-pipe analogy 23 is a well-documented analogy to explain the flow of charge. Learners start

constructing knowledge with prior knowledge that they have before they enter the classroom. When they are introduced to an analogy, they already create an idea of how it relates to the real situation. “We found that the reason the students had difficulty understanding the concept of chemistry was because of their ontological presupposition of the concept”. They use their existing knowledge of what they understand about the situation and make sense of concepts based on this understanding and find it difficult to reassign that concept to another set of ideas. Therefore, if they have a particular understanding of how something works, they interpret any new knowledge in accordance with their pre-existing idea. However, it is important to find a link between the previous knowledge and the expected target, proposed the Structure-mapping theory which opened a whole new field of how a man can solve and confront problems. The theory indicates the relationship between the familiar and unfamiliar domain and how analogies can help in the construction of knowledge, “through the analogical relationship between the domains” [43].

These mental images or mental representations are known as “mental simulations” of the real situation describes this phenomenon as analogical representations of reality or a working model. This theory has played a key role in science because it is understood that it is used by novices and experts for different reasons but allows for creative thinking. Famous philosophers and scientists such as Plato, Aristotle, Maxwell and Franklin have found that analogies play a crucial role in theory development itself. Teachers who are unaware of analogies themselves struggle to find analogies that are “the same as the real thing”. Yet, analogies should not be seen as a simplistic solution argues that analogies are not effective because they do not bring about conceptual change [44].

Instead, using analogies allows for “assimilating new knowledge” and “served as references for initial explanations or conjectures”. Therefore, the use of an analogy will only be effective if the learner is able to construct new knowledge or other assimilated knowledge. Furthermore, there are studies that have found that analogies may cause a great amount of confusion. Claims that the teachers’ role in using analogies is a crucial one. He believes that if the teacher does not scaffold the lesson so that learners move towards the knowledge they are meant to construct, it may cause many misconceptions, looked at the range of analogies that were used to explain concepts and found that inappropriate analogies create misconceptions [45].

2.5.Concepts in chemical bonding

It is well known that during the learning process, students construct new knowledge from their previous ideas, skills and experience. Sometimes the students’ ideas are not consistent with scientific conceptions and, then, misconceptions, alternative frameworks or preconceptions account. All of them negatively affect the learning and make difficult to build new concepts consistent with the accepted scientific ideas. Therefore, it is highly desirable to precisely know them for an effective teaching methodology [46].

One of the most powerful and productive ideas in chemical education is the fact that chemical knowledge can be generated, expressed and taught at three levels, known as macroscopic, microscopic and symbolic. The macroscopic level includes the observable properties or facts that students may face in their daily lives. The microscopic level includes particles (electrons, atoms, ions and molecules) and their interactions (chemical bonds and chemical reactions).The symbolic level represents the chemical processes in terms of formulas and equations. These levels are interrelated, so that the students' knowledge of each of these levels is very important to clearly understand the chemical processes [49].

However, it has been reported that not making a proper connection between these three levels leads to one of the most important reasons for the misconceptions of students [48]. Research shows that by using an alternative instructional program designed to enhance secondary students' competence in the triplet relationship is possible to achieve more meaningful learning of chemical representations [50].

The chemical concepts involving bonds between atoms and/or molecules are enough abstract and far apart from the daily experience which may explain the difficulties of understanding. These difficulties are an important source of misconceptions that must be minimized, as much as possible, given the crucial importance of the chemical bond concept in order to successfully address the study of other areas of chemistry such as chemical reactions, structure of matter, organic compounds, proteins, polymers [50].

Up today, literature provides extensive and relevant research on students' misconceptions related to chemical bonding. Among others, it should be worthwhile to mention the following studies in chronological order;

- ✓ Those where students cannot differentiate ionic and covalent bonding
- ✓ Those where students poorly understand the electrostatic nature of the chemical bond
- ✓ Those with misconceptions about the polarity of molecules.
- ✓ Those where students confuse intra- and intermolecular forces
- ✓ Those presenting misconceptions on melting and boiling points or on solubility and electrical conductivity of substances
- ✓ Those where sometime students attribute macroscopic properties to particles, mixing two different levels of knowledge [55].

For all these reasons, have analyzed how the chemical bond is taught and have underlined those aspects of the traditional teaching that can contribute to the difficulties in learning. Consequently, they proposed a new approach to teach chemical bond in accordance with actual scientific and pedagogical knowledge [56].

2.6. Identifying students' conceptions

Multiple-choice items can be used to evaluate students' content knowledge in a topic. However, they are not without limitations. Multiple-choice items often involve a limited number of short answer options without elaboration of the reasons. To address the limitations of multiple-choice items incorporated known alternative conceptions in the responses and required students to provide a reason for selecting a particular response [57].

The provision of justifications to address the limitation of multiple-choice items, proved to be more sensitive and effective in assessing students' learning. This positive outcome led to the development of two-tier multiple-choice items by that enabled the identification of students' alternative conceptions in specific content areas. The first tier is a content question followed by a number of multiple-choice options. The second tier provides a number of alternative justifications for the choice of the answer to the first tier. These short pencil and paper tests are convenient to administer and it does not take long to mark manually. For large samples, specially designed answer sheets can be marked efficiently using optical marking machines that electronically read the answers and summarize the responses in a data file for subsequent analysis. It has provided useful guidelines for the development of instruments containing two-tier multiple-choice items, provides a sample scheme for this development. The development of two-tier multiple-choice diagnostic instruments has been reported in the science education research literature since the 1980s, involving a variety of concepts [51].

According to literature the most frequently encountered misconceptions are given below: Students lack a scientific concept of the chemical bonding. Most of the students do not identify the ionic bonding, covalent bonding and metallic bonding; students frequently make mistakes about the macroscopic level of representation of substance with the microscopic level of atoms and molecules [55].

CHAPTER THREE

3. METHODOLOGY

3.1.Research area description and target population

The study was conducted in Kutere Secondary School (grade 9), which is found in, Silte Zone, Central Ethiopia, Ethiopia. The school was intentionally chosen for this study because the researcher works as a chemistry teacher of the target school and the existing situation would enable him to conduct research on the topic and come up with a reliable inquiry. The Target population of the study included 360 grade 9 students of Kutere Secondary School. Out of these the researcher selected 72 students by employing a stratified sampling method by using gender.

To gather sufficient and relevant data for the study the target population of the study includes all 360 of grade 9(A-F) students of Kutere secondary school. In 2015E.C.The number of grade 9 students enrolled was about 360 of the enrolled students 184 were males and the rest 176were females Table (2) below indicates the number of respondents and the target population used in the study.

Table 3.1: Distribution of students with respect to sex and classes.

No	Region	Town	School	Ownership	Enrolled students		
	Central Ethiopia	Kutere	Kutere	Government	M	F	T
1			9A		30	30	60
2			9B		31	29	60
3			9C		32	29	61
4			9D		30	28	58
5			9E		31	30	61
6			9F		30	30	60
Total					184	176	360

Research methodology is the way how the research was conducted. It includes research design, research area descrtption, sample size and sampling technique, data collecting instruments, data collecting procedure, data analysis technique, and some ethical issues.

3.2.Data collection procedure

The researcher asked permission from the school principal in order to conduct the study. The school principal permitted the researcher to conduct the research in the school and facilitated the class rooms for the study. Therefore, the questions of the test were distributed amongst the students to get pre-test information and then recorded. Some sample questions (Pre and post- tests) were prepared for the sample students and given for them. The pre-test given for the sample students (control and experimental group) before any treatment and the data collected. Also data collected from post-test from both groups. The two tests given for the sample students in two sessions. An interview questions were also included after post -test in order-gather farther information.

3.3.Research design

For this study, the research design employed was a descriptive survey. Surveys describe the nature of the existing situation, or identify standards against which the existing situation to be determined the relationships exist between specific events.

To take problems related to difficulties of student's conceptual and computational skills and describe their status the researcher was used mixed method approach. Since the objective of this study is identifying and minimizing students' misconception in chemical bonding that they have holding currently, the appropriate design and type of research selected by the researcher is a non-experimental descriptive survey type.

The data was collected from primary sources and both quantitative and qualitative (mixed) approaches were used for data analysis and interpretation. Quantitative approach was used to describe students' conceptions from achievement test results. Qualitative approach was used to describe the students' conceptions from open ended questions (interviews).

Table3. 2: Frame work of research design

Based on	**Type of research**
Design	Descriptive survey
Approach	Mixed
Goal	Applied
Types of data	Primary
Field of study	Chemistry

3.4. Sample size and sampling technique

The subjects of the study were grade 9 students. There were 184 male and 176 female totally 360 grade 9 students from six sections in the school. According to one rule of thumb for determining an adequate sample

size for descriptive research is that it should consists of 10%-20% of the population under study of these, the researcher intended to take 20% of the population as sample size of the study. The reason why students were chosen randomly from the six sections was to give each sections' students an equal chance of being selected[59].

To attain the purposes of the research, the researcher used a stratified random sampling technique. Stratified random sampling is a sampling technique that involves the identification of important sub groups in a particular population. A total of 72 students, which are 20% from the population, was selected for this study as sample size. In this case the sub groups were allocated from the six sections and the sample size required was 72, so n=72, the total population was 360, so N=360 then the proportion was n/N = 72/360 = 1/5= 0.2 and multiply the members in each section by the obtained proportion i.e. 0.2 this gives you the number of members to be included in the sample. The sample students were randomly assigned to experimental and control groups.

Table 3.3: personal data of sample students of grade 9

No	Section	Students	Sample size	Experimental group	Control group
1	9A	60	60x0.2 =12	6	6
2	9B	60	60x0.2=12	6	6
3	9C	61	61x0.2=12.2	6	6
4	9D	58	58x0.2=11.6	6	6
5	9E	61	61x0.2=12.2	6	6
6	9F	60	60x0.2=12	6	6
Total		360	360x0.2=72	36	36

3.5.Data collecting instruments

Questionnaire (pre-test and post-test) were developed and used. These instruments include chemistry performance tests which are divided in to pre-test and post-test . Accordingly, the data gathering instruments for this study were conceptual understanding test and tested for item difficulty, reliability and validity by subject teachers.

3.6.Piloting test

3.6.1. Validity

The instrument was given to two experienced high school teachers to obtain their views regard the appropriateness of objective, language level, comment the item and match items to objectives.

Moreover, pilot test was conducted in order to calculate item difficulty index and discrimination index. Based on their feedback, corrections and changes were made after the test was used for data generation. Validity is the extent to which an instrument measures what it is supposed to measure.

3.6.2. Reliability

The reliability of conceptual understanding test was checked by calculating the reliability coefficient for multiple-choice instructions. The reliability coefficient is a measure of the error associated to the students‘ scores its values can range from 0 to 1 A reliability coefficient of zero would indicate the instrument does not consistently measure anything while coefficient of 1 would indicate the instrument has no measurement error.

Table 3. 4: Reliability of the pilot test and conceptual understanding test for the sample

The reliability of pilot test	The reliability of conceptual understanding test
0.74	0.75

If the reliability of alpha coefficient is:

- 0.90 and above is excellent
- 0.80-0.90 is very good for classroom test
- 0.70-0.80 is good for classroom test
- 0.60-0.70 is somewhat low
- 0.50-0.60 suggest need for revision
- 0.50 or below is questionable reliability

Based on this criterion, the reliability of the pilot test and conceptual understanding test lied within good range for classroom test.

3.6.3. Item difficulty index

This is a measure of the difficulty of a particular question. It is the ratio of the number of students, who answered the question correctly to the total number of students, taking the test.

$$P(D)_{value} = \frac{number of peoples\ responding correctly}{number of peoples\ taking the test}$$

A difficulty index value in the range of 0.2-0.8 is conventionally considered adequate (Kubiszyn and Borich 2003). A value less than 0.2 indicate that, the questions are too difficult for discriminating and a value more than 0.8 indicates that the question is too easy.

3.7.Data analysis techniques

Both quantitative and qualitative data analysis techniques were used, moreover, descriptive statistics was applied to calculate their percentage mean and standard deviation. For analysis of data SPSS statistics version 20 was used.

3.8.Ethical consideration

Bryman argued that ethics are part and package of the paradigm position held by the researcher while conducting a research. The basic ethical consideration in conducting a research is informed consent. Thus, while conducting close-ended questionnaires, the researchers were request the oral consent of the participants by clearly explaining the objective and significance of the study. The participation of each participant was also base on their willingness (voluntarily). They were pre-informed that, they could quit their participation if they felt discomfort without looking permission from the researcher [60].

CHAPTER FOUR

4. RESULT AND DISCUSSION

This chapter deals with analysis and of the data collected through conceptual understanding tests (pre and post-tests) from students. The chapter also presents misconceptions reflected by students and discusses them thematically to answer the research questions raised in chapter one.The analysis of the data has been carried out in an integrative way based on the major themes and sub themes of the study. The presentation falls into four main sections. The first section deals with Students' misconceptions about chemical bonding. The second section discuses other misconceptions on chemical bonding concepts with in selected students and the third section focuses on the causes of misconceptions and the last section focuses on the solutions how can this misconceptions can be minimized (avoided).

4.1.Data analysis and interpretation of conceptual understanding (pre-test) tests

In order to identify and characterize misconceptions,conceptual understanding test was used. Conceptual understanding test provide academic opportunity for comparing the status of particular conception in different individuals. It may therefore possible to identify the status of each conceptions not by isolation, but rather by studying each of related conceptions and the reasoning statements which link them and indicate the range of conditions under which each conceptions is to be used. Conceptual understanding test was administered to the target groups. The result scores on each item of students obtained was recorded and analyzed as follows

4.2.Test score results

4.2.1. Pre-test score result

Table 4.1: the frequency distribution of score of experimental and control group students

Control group			Experimental group		
No	Out of 12	100%	No	Out of 12	100%
1	4	33.3	1	5	41.6
2	5	41.6	2	4	33.3
3	3	25	3	4	33.3
4	4	33.3	4	4	33.3
5	5	41.6	5	3	25
6	3	25	6	6	50
7	4	33.3	7	4	33.3
8	4	33.3	8	5	41.6
9	3	25	9	4	33.3
10	4	33.3	10	4	33.3
11	5	41.6	11	3	25
12	6	50	12	3	25
13	7	58.3	13	4	33.3
14	4	33.3	14	4	33.3
15	3	25	15	6	50
16	4	33.3	16	4	33.3
17	5	41.6	17	6	50
18	6	50	18	4	33.3
19	7	58.3	19	4	33.3
20	4	33.3	20	3	25
21	5	41.6	21	7	58.3
22	4	33.3	22	4	33.3
23	4	33.3	23	5	41.6
24	4	33.3	24	4	33.3
25	4	33.3	25	3	25
26	4	33.3	26	3	25
27	5	41.6	27	4	33.3
28	5	41.6	28	4	33.3

29	3	25	29	4	33.3
30	3	25	30	3	25
31	4	33.3	31	6	50
32	5	41.6	32	7	58.3
33	4	33.3	33	4	33.3
34	6	50	34	4	33.3
35	3	25	35	3	25
36	4	33.3	36	4	33.3
Mean=1315.	6 /36 =36.5			Mean=1274.1/36=	35.4

4.2.2. Analysis and interpretations of pre-test

The Conceptual understanding test(pre-test) was designed to find out the levels of student's misconceptions in chemical bonding by using scoring criteria. Scores could range from 0 to 100. Scores that are greater than 75 were classified to show performance of low misconception in chemical bonding, scores 50-74 were classified to indicate normally moderate misconception in chemical bonding concept and scores less than 50 were classified to show high misconception in chemical bonding. As above table(4.1) indicated, the pre-test mean score on the chemical bonding subject of control group students was 36.5 and experimental group students mean score was 35.4 before any treatment. These that there was no more significant difference between control and experimental group students before any treatment. Therefore, from the above analysis both groups are categorized under high misconception.

Table4.2: Frequency distribution of students' score of pre-tests

Score	N(con)	%	Score	N(ex)	%
75-100	0	0	75-100	0	0
50-74	5	13.8	50-74	6	17
0-49	31	86.2	0-49	30	83
Total	36	100	Total	36	100

As above table(4.2) indicated, the number of students who earned score greater than 50% in the pre- test are only 6 from experimental group and there were only 5 students that earned 50% and above from control group in the pre-test. Therefore, from the above analysis both groups are categorized under high misconception.

Table 4.3: Categorization of students' answer on pre-test

No	Category level	Categorydistribution	Frequency		Frequency out of 72 st	100%
			Con. Group	Exp. group		
1	1	CR	17	15	32	44.4
	2	WR	21	19	40	55.6
2	1	CR	10	12	22	30.6
	2	WR	26	24	50	69.4
3	1	CR	13	15	28	38.9
	2	WR	23	21	44	61.1
4	1	CR	7	6	13	18
	2	WR	29	30	59	82
5	1	CR	17	17	34	47.2
	2	WR	19	19	38	52.8
6	1	CR	7	9	16	22.2
	2	WR	29	27	56	77.8
7	1	CR	19	18	37	51.4
	2	WR	17	18	35	48.6
8	1	CR	14	12	26	36.1
	2	WR	22	24	46	63.9
9	1	CR	16	15	31	43.1
	2	WR	20	21	41	56.9

10	1	CR	15	14	29	40.3
	2	WR	21	22	43	59.7
11	1	CR	5	7	12	16.7
	2	WR	31	29	60	83.3
12	1	CR	10	10	20	27.8
	2	WR	26	26	52	72.2

4.3.3. Analysis of the categories (pre-test) result

The analysis of the reasoning categories obtained from the pre-test results were presented in the relation to the reports on students' misconceptions in chemical bonding subject concepts.Students' misconceptions similar to the ones in the literature were identified in order to construct the distracters onthe multiple choice items on the chemical bonding and intermolecular forces.

The 1st question focuses on the formation of ionic bonding, most of the students about 55.6% answered ionic bonding is formed by transfer of electron from one atom to the element of the same atom, the students did not choose the electrostatic force of attraction between oppositely charged ions, so this indicates there is misconceptions in students of grade 9 in ionic bond formation concept.

The second question was related to the type of electrons that take part in chemical bonding , some of the students about(69.4%) in the sample preferred all electrons found in the atom take part in the reaction, which is wrong, shows that there was misconception here. But 30.6% of the students answered correctly.

The 3rd question goes to the relationship between polarity and solubility, which says potassium chloride (KCl), soluble in water but insoluble in benzene. The respondents (about 61.1%) responded wrongly. So most of the students do not understand ionic compounds are generally soluble in polar solvents.

The 4th item raised the formation of covalent bonding concept, (about 82%) answered that covalent bond is formed by gaining and losing of electrons which is false concept.so there is some prior knowledge which disturbed them.

The 5th item compared polarity of HCl and Cl_2, Most of the studentsa bout (52.8%) chose both of them are non- polar species, which is wrong answer. This indicates there is gap related to polar and non-polar compounds/molecules.

The response of item 6, which asks the intermolecular force that exist between water molecules, most students responded wrongly (about 77.8%) also there is a difficulty in intermolecular force that bind water molecules together.

When students asked to compare pure covalent and coordinate covalent bond in item7, they answered (about 48.6%) the two bonds are similar. Therefore, there is gap regarding to the item raised.

The 8th item asked the respondents to identify polar molecule from non-polar molecule, the students (about 63.9%) shown difficulty in identifying polar molecule from non-polar molecule.

Item 9, asked the concept of polar- non polar bond, but the students about 56.9% fail to explain and choose the correct response, this indicates that they are in some difficulty of learning.

Item 10, asks the respondents to identify if any misconception related to interferences between metallic bonding and ionic bonding , most of the students about 59.7% think metallic bonding is similar to ionic bonding, which is also great difficulty identified from the sample students.

The 11th item asked the students if any difference between intermolecular and intramolecular forces, most of the students (about 83.3%) didn't answered correctly, this indicates that there is some learning difficulties.

The response of the students for question 12 which says covalent compound conduct electricity in aqueous solution again there is wrong answer (about 72.2%). So, there is some difficulties over here.

Generally the analysis of the conceptual understanding test (pre-test) demonstrated that students' knowledge on the chemical bonding concept was fall in to several difficulties. Students were expected to identify between ionic bond, covalent bod and metallic bond and also expected to distinguish pure covalent bond from coordinate covalent bond. As seen from above table the students were under difficulty in distinguishing polar and non-polar bonds as well as molecules and also there were misconceptions on general properties of ionic and covalent compounds .The students were also in difficulties of distinguishing between intermolecular and intramolecular forces as well they shown misconceptions on solubility as well as conductivity of ionic and covalent compounds.

Table 4.4 : Comparison of pre –test by mean and standard deviation

Types of test	Group	N	Minimum	Maximum	Mean	Std.Deviation
Pre-test	Control	36	25.0	58.3	36.5	9.18
	Experimental	36	25.0	58.3	35.4	9.20

In order to determine the current status of the students' chemical bonding misconceptions there by measure the effects produced due to the various methods of learning, pre-test was conducted. Accordingly, the pre- test mean score was presented in the above table 4.4. From the result, the pre- tests mean score of the control group students was 36.5, which was slightly higher but not significantly different from the mean score of the experimental group 35.4. The mean score values obtained from the students' pre-test result revealed that the students'chemical bonding concept was below the average. There was no significant difference between the two groups means (control and experimental) before

any treatment. When the score of both group compared with standard deviation, there was no significant difference between the two groups (9.18 and 9.20) for control and experimental groups respectively.

Table 4.5: Comparison of pre- test by standard deviation, mean and t-test

Pair	Paired difference					T-test	Df	Sig((P)
control group Vs experimental group	Mean	Std. Deviation	Std. error	95% confidence interval of the difference				
				Lower	Upper			
	1.15	13.23	2.205	-3.32	5.63	0.52	35	0.605

As table 4.5 indicated, the result of the t- test analysis revealed that there was not a significant difference (p =0.605) in the pre-test scores of the control group and the experimental group learners' in the chemical bonding subject. This was because the observed p- value of 0.605 is greater than the p-value (0.05) standard. So it can be concluded there was no significant difference between the two groups (control and experimental) pre-test scores.

4.4 Analysis and interpretation of interview questions (1st)

For interview 30 students randomly selected by simple random sampling technique. The analysis of the interview questions was seen as follows.

For IQ1, A. The interview result showed that 11 students or 36.7% explained that ionic bond is formed electrostatic force of attraction between positive ions(cations) and negative ions(anions), but 19 students or 63.3% of them had difficulty in explaining the formation of ionic bonding. This information of respondents interview show most of the students were in difficulties of ionic bond formation.

For IQ1,B. the interview result shown only 9 (30%)students also explained well about covalent bond formation,but 21(70%)students were under difficalty in the formation of covalent bonding.

For IQ 2,A. The interview results shown 14 students or 46.7% there are 3 types of chemical bonds,but 16(53.3%) students answered 4 types and which is false.most of the students were in misconceptions.

For IQ 2,B. also 12 students(40%) mentioned the 3 types of bonds as ionic,covalent and metallic, the rest 18 students (60%) mentioned incorrectly and they are in misconceptions on ionic and covalent bond formation.

For IQ 3,A. From the interview 13 students or 43.3% mentioned the general properties of ionic compounds , but 17 students or 56.7% failed to mention the properties of ionic compounds.

ForIQ 3,B. about 14 (46.7%) students correctly mentioned the general properties of covalent bond, but 16(53.3%) students fail to mention the general properties of covalent compounds.

IQ 4,A. The interview responses of students showed that 10 students or 33.3% said yes, ionic compounds can conduct electricity in aqoues solution, but the rest 20 students (66.7%) answered incorrectly. There was misconception.

IQ 4,B. the interview response 8 students (26.7%) said covalent compounds do not conduct electricity in molten state or in aqeous solution.the rest 22 students (73.3%) responded incorrectly that covalent compounds can conduct electricity in aqeous solution.

For IQ 5,A. The interview question that asked the difference between polar and non polar bonds 12 students(40%) responded correctly that polar bond is formed between atoms whch have an electronegativity gap (between the most electronegative and the least electronegative elements). The rest 18 students (60%) answered incorectly.

For IQ 5,B. intervies response of 13 students (43.3%) said water is polar molecule, for why, they answered because water is composed of the most velectronegative element oxygen and the least electronegative element hydrogen.the rest 17(56.7)students responeded incorrectly that water is non polar,and have't reason out.

For IQ 6, A. Interviews response of 10 (33.3%)students responded correctly that intermolecular forces are weak forces that exist between molecules, but 20 (66.7%)students responded incorrectly that both of them are similar.

For IQ 6,B. 14(46.7%)students responded inermolecular and intramolecular forces are completley different, intermolecular forces are weak forces that exist between molecules but intramolecular forces are pure covalent bonds that exist between atoms.the rest 16(53.3%)responded incorrectly.

In general one can conclude from the interview response most of the students were in high misconception the concept of chemical bonding.

4.5 Treatment of students after analysis of the pre-test results

Based on the result of pre-test action was planned by the researcher to overcome or minimize the misconception of students' in chemical bonding subject in grade 9 Kutere secondary school, Silte zone. After the analysis of the pre-test the experimental group treated in a separate way to compare the result with that of control group. The chemical bonding subject was taught for experimental group for about 6 weeks as tutorial class. There were also chemical models used to clarify the chemical bonding concept.

But that of control group treated as usual but equal time was spent in teaching and learning process. Additional class only for the experimental group was given for six weeks once per a week (12hrs).

4.5.1 Action strategies

Different strategies and methods were implemented to minimize the misconceptions seen in chemical bonding and intermolecular forces among the students.

- Tutorial classes (additional classes only for experimental group)
- During tutorial class different teaching materials used (eg. Models, diagrams)
- Concept mapping approach method was also implemented for teaching learning activity
- Locally available instructional materials like stick and bond model were used to develop concepts.

4.5.2 Action plan

Table 4.6.Action plan

Week	Topics	Duration of time	Teaching methods
1	Types of chemical bonding	2’	-Explanation using concept mapping,group discussion
2	Formation of ionic bonding	2’	Explanation using diagrams (charts)
3	General properties of ionic compounds -solubility and conductivity	2‘	-Explanation and laboratory activity (solubility and conductivity of ionic compounds in both polar and non -polar solvents)
4	Covalent bond formation and general properties of covalent compounds -solubility and conductivity	2’	-Explanation and laboratory activity (solubility test and conductivity test of covalent compounds)
5	-coordinate covalent bond -polar and non-polar covalent compounds	2’	Explanation using more examples

6	-Metallic bonding -Intermolecular forces(dipole-dipole, hydrogen bonding and London dispersion force	2’	-Explanation on metallic bonding and properties of metals (lab. Activity) -Explanation on intermolecular forces and intramolecular forces

4.5.3. Action implementation

After the preparation of action plan, the action implementation takes place for six weeks, 2 hours in a week. After the action implementation post-test was prepared from chemical bonding and intermolecular forces topics and administered to both groups(control and experimental) at the same time. The time interval given for the post-test was about 1 hour. Like pre-test also the number of post-test items was 12 and converted to 100. The sample students' performance of the post-test was evaluated, analyzed, interpreted and tabulated as follows

4.5.4 Action evaluation (post-test)

After implementation, action evaluation was done as a post-test

Table 4.7: Frequency distribution of post-test score of control group and experimental group students

Control group			Experimental group		
No	Out of 12	100%	No	Out of 12	100%
1	5	41.6	1	6	50
2	4	33.3	2	8	66.6
3	6	50	3	7	58.3
4	4	33.3	4	9	75
5	3	25	5	5	41.6
6	7	58.3	6	9	75
7	6	50	7	7	58.3
8	4	33.3	8	6	50
9	5	41.6	9	5	41.6
10	3	25	10	3	25
11	3	25	11	8	66.6
12	4	33.3	12	6	50
13	5	41.6	13	7	58.3
14	3	25	14	5	41.6
15	4	33.3	15	4	33.3
16	3	25	16	8	66.6
17	7	58.3	17	6	50
18	3	25	18	8	66.6
19	4	33.3	19	4	33.3
20	5	41.6	20	7	58.3
21	5	41.6	21	7	58.3
22	6	50	22	10	83.3
23	4	33.3	23	8	66.6
24	4	33.3	24	6	50
25	5	41.6	25	5	41.6
26	4	33.3	26	4	33.3
27	5	41.6	27	6	50
28	4	33.3	28	8	66.6
29	7	58.3	29	6	50

30	3	25	30	5	41.6
31	6	50	31	6	50
32	5	41.6	32	7	58.3
33	4	33.3	33	8	66.6
34	6	50	34	9	75
35	5	41.6	35	8	66.6
36	4	33.3	36	6	50
Mean=1373.3/36=38.2			Mean =1973.8/36=54.83		

4.6 **Analysis and interpretations of post-test**

The Conceptual understanding test was designed to find out the levels of students' misconceptions in chemical bonding by using scoring criteria. Scores could range from 0 to 100. Scores that are greater than 75 were classified to show performance of low misconception in chemical bonding, scores 50-74 were classified to indicate normally moderate misconception in chemical bonding concept and scores less than 50 were classified to show high misconception in chemical bonding. As above table (4.7) indicated, the post-test mean score on the chemical bonding subject of control group students was 38.2 and experimental group students mean score was 54.83 after treatment. This result shown that there was significant difference between control and experimental group students after treatment. The number of students who earned score 50% and above in the post-test were about 27 of 36 from experimental group and there were only 8 of 36 students that earned 50% and above from control group in the post-test. Therefore, from the above analysis the misconceptions of students in experimental group minimized some what by treatment such as tutorial class, laboratory activities and also giving additional time to treat them by using appropriate teaching and learning method.

Table 4.8: Frequancy distribution of students score of post-test

Score	N(con)	%	Score	N(exp)	%
75-100	0	0	75-100	4	11.1
50-74	8	22	50-74	23	63.9
0-49	28	78	0-49	9	25
Total	36	100	Total	36	100

As above table (4.8) indicated, the number of students who earned score greater than 50% in the post-test are 27 from experimental group and there were only 8 students that earned 50% and above from control group in the post-test. Therefore, the misconceptions of students in experimental group minimized some what by treatment such as tutorial class, laboratory activities and also giving additional time to treat them by using appropriate teaching and learning method.

Table 4.9. Categorization of students' answer on post-test

No	Category level	Category disribution	Frequency		Frequency out of 72 st	100%
			Cont.group	Expe.group		
1	1	CR	16	22	38	52.8
	2	WR	20	14	34	47.2
2	1	CR	13	28	41	57
	2	WR	23	8	31	43
3	1	CR	8	28	36	50
	2	WR	28	8	36	50
4	1	CR	15	29	44	61
	2	WR	21	7	28	39
5	1	CR	9	30	39	54.2
	2	WR	27	6	33	45.8
6	1	CR	16	33	49	68
	2	WR	20	3	23	32
7	1	CR	17	21	38	52.8
	2	WR	19	15	34	47.2
8	1	CR	6	26	32	44.4
	2	WR	30	10	40	55.6
9	1	CR	10	29	39	54.2

	2	WR	26	7	33	45.8
10	1	CR	12	24	36	50
	2	WR	24	12	36	50
11	1	CR	11	30	41	56
	2	WR	25	6	31	44
12	1	CR	7	22	29	40.2
	2	WR	29	14	43	59.8

4.6.1 Analysis of the categories (post-test) result

The analysis of the reasoning categories obtained from the post-test results were presented in the relation to the reports on students'misconceptions in chemical bonding subject concepts.

Students' misconceptions similar to the ones in the literature were identified in order to construct the distracters on the multiple choice items on the chemical bonding and intermolecular forces.

Item 1, asked the type of covalent bond formed by unequal sharing of bonding electrons, the stu dents about 52.8% answered correctly. Most the students chose the correct response were from the experimental group, this indicates that the special treatment was somehow minimized the learners misconceptions in formation of polar bond.

Item 2, asks the respondents to identify if any misconception related to interferences between metallic bonding and ionic bonding , most of the students about 57% think metallic bonding is different from ionic bonding after special treatment.

The 3rd item asked the students if any difference between intermolecular and intramolecular forces, half of the students (about 50%) answered correctly as intermolecular force exists between molecules,but that of interamolecualr force exists between atoms.

The response of the students for question 4 which says general properties of covalent compounds in terms of electrical conductivity in aqueous solution as well as in solid state, about 61% answered correctly from the total of sample students.

The 5th item compared polarity of HCl and Cl_2, Most of the students about (54.2%) answered HCl is polar but Cl_2 is non polar species, which is correct answer.

The response of item 6, which asks the intermolecular force that exist between water molecules, most students responded correctly (about 68%), the type of intermolecular force that exist between water molecules is hydrogen bonding.

When students asked to compare pure covalent and coordinate covalent bond in item7, they answered (about 52.8%) correctly. the coordinate covalent bond is the type of covalent bond in which the bonding electrons contributed by one of the atom(s).

The 8th item asked the respondents to identify polar molecule from non-polar molecule, the students (about 44.4 %) answered correctly and still some students show certain misconceptions. .

The 9th question focuses on the formation of ionic bonding, most of the students about 54.2% answered ionic bonding is formed by the electrostatic force of attraction between oppositely charged ions

The 10th question is related to the type of electrons that take part in chemical bonding, some of the students about (50%) in the sample preferred outer most shell.

The 11th question goes to the relationship between polarity and solubility, which says potassium chloride (KCl), soluble in water but insoluble in benzene. The respondents (about 57%) responded correctly. So most of the students understand ionic compounds are generally soluble in polar solvents and insoluble in non-polar solvents like benzene.

The 12th item raised the formation of covalent bonding concept, (about 40.2%) answered that the attraction of positively charged nuclei and the shared electrons in the molecule.

Generally the analysis of the conceptual understanding test (pos-test) demonstrated that students' knowledge on the chemical bonding concept was maximized by using special treatment such as tutorial class, laboratory activities and also giving additional time to treat them by using appropriate teaching and learning method. Students were expected to identify between ionic bond, covalent bond and metallic bond and also expected to distinguish pure covalent bond from coordinate covalent bond. As seen from above table 4.9 most the students answered the questions and distinguished polar and non-polar bonds as well as molecules and also their conceptions on general properties of ionic and covalent compounds was changed .The students were also identified between intermolecular and intramolecular forces as well they shown good understanding on solubility as well as conductivity of ionic and covalent compounds.

4.7 Analysis and interpretation of interview questions (2nd)

For interview 30 students which have better score are selected by simple random sampling technique. The analysis of the interview questions are seen as follows.

For IQ 1, A. The interview result showed that 20 students or 66.7% explained that ionic bond is formed electrostatic force of attraction between positive ions (cations) and negative ions (anions), but 20 students or 33.3% of them had difficulty in explaining the formation of ionic bonding. This information of respondents interview show most of the students concept is good in ionic bond formation.

For IQ 1,B. the interview result shown about 16 (53.3%)students also explained well about covalent bond formation,but only 14 (46.7%)students were under difficalty in the formation of covalent bonding

For IQ 2, A. The interview results shown 21 students or 70% there are 3 types of chemical bonds,but 9(30%) students answered 4 types and which is false.most of the students were in low misconceptions after special treatment.

For IQ 2,B. also 21 students(70%) mentioned the 3 types of bonds as ionic,covalent and metallic, the rest 9 students (30%) mentioned incorrectly.so the additional class for experimental group students minimized the misconceptions on ionic and covalent bond formation.

For IQ 3,A. From the interview 18 students or 60% mentioned the general properties of ionic compounds , but 12 students or 40% failed to mention the priperties ionic compounds.

forIQ 3,B. about 17 (56.6%) students correctly mentioned the general properties of covalent bond, but 13(43.4%) students fail to mention the general properties of covalent compounds.from the interview question one can understand that the misconception identified in the pre-test was some how minimized.

IQ 4, A. The interview responses of students showed that 23 students or 76% said yes, ionic compounds can conduct electricity in aqueous solution, but the rest 7 students (24%) answered incorrectly. From the answer of students one can conclude that the misconception of students minimized by special treatment by giving tutorial class and laboratory activities for experimental group.

IQ 4, B. the interview response 17 students (56%) said covalent compounds do not conduct electricity in molten state or in aqueous solution,the rest 13 students (46%) responded incorrectly that covalent compounds can conduct electricity in aqueous solution.The concept of students in general properties of conductivity of ionic and covalent compounds is increased.

For IQ 5,A. The interview question that asked the difference between polar and non polar bonds 12 students(40%) responded correctly that polar bond is formed between atoms whch have an electronegativity gap(between the most electronegative and the least electronegative elements). The rest 18 students (60%) answered incorectly.

For IQ 5,B. intervies response of 21 students (70%) said water is polar molecule, for why, they answered because water is composed of the most velectronegative element oxygen and the least electronegative element hydrogen.the rest 9 students responeded incorrectly that water is non polar,and have’t reason out.

For IQ 6,A. Interviews response of 20 students or 66.7% responded correctly that intermolecular forces are weak forces that exist between molecules, but 10 students or 33.3% responded nincorrectly that both of them are similar.

For IQ 6,B. 20 students responded inermolecular and intramolecular forces are completley different, intermolecular forces are weak forces that exist between molecules but intramolecular forces are pure covalent bonds that exist between atoms.Therefore, the misconception of students was minimized by treating them specially by giving additional class and appropriate teaching method.

In general from the intreview response of the stdents shown the misconception on chemical bonding was minimized by treating the students in especial way (tutorial class, laboratory activities and by using apropriate instructional method and materials.

4.8 Finding and discussion

RQ 1,What are grade 9 student's misconceptions about chemical bonding concepts?

From the pre-test score it was understood that most students from both groups (control and experimental) students of Kutere secondary school fail to respond correct answer for the question that asks the formation of ionic bonding, covalent bonding, the general properties of ionic and covalent compounds (see,Appendice I), this indicates there were misconceptions regarding to chemical bonding.But after identifying the misconceptions by using pre- test the researcher treated the experimental group specially by giving tutorial,and another laboratory activities and then post test was administered. As a result of post-test indicated (see table 4.7) the students' misconception was minimized. After laboratory activities and other additional teaching the learners understanding was shown a progress. This was evaluated from the post-test result

RQ 2, What are other misconceptions on chemical bonding concepts with in sample students?

Here again the students fail to distinguish solubility in relation to polar and non-polar solvents in the pre-test (CQ3). After laboratory activities and other additional teaching the learners understanding was shown a progress. This was evaluated from the post-test result

Again students do not distinguish intermolecular and intramolecular forces in pre-test.Also this was another misconceptions towards the sample students in the pre-test and it agrees with other researches[50].

RQ 3, What are the causes of these misconceptions on chemical bonding concepts?

The sources of the students' misconceptions that were identified by the researcher are methods of teaching methodology, language utilization of the teachers, short time for normal class period, media and communication and prior knowledge from the learners were some challenges that face Kutere secondary school students, which agrees with the misconceptions of students in many researches [21].

RQ4, What are the solutions for the occurring factors?In order to minimize misconceptions the school teachers must use chemical language to teach chemistry, as well chemical bonding subject.

Tutorial classes, cooperative teaching-learning methods, laboratory activities and appropriate class size and class time must be implemented. Also it is better teachers to understand the background concept of the learners before teaching new concepts [53].

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 Summary

It was realized that, students have considerable degree of misconceptions about chemical bonding. Identifying and characterizing students' misconceptions before providing instruction benefits for the targeted learners in terms of developing better conceptual understanding, offering a better opportunity for supporting the students' future career. As mentioned earlier, the main purpose of the study was identifying and minimizing students 'misconceptions on chemical bonding with reference to grade 9 students at Kutere Secondary School in Silte Zone of central Ethiopia. The study focused on identifying major problems that students face when they were learning chemical bonding subject, identifying causes for students' problems in understanding chemical bonding concepts and how chemistry teachers attempt to help students in overcoming (minimizing) the problems.

For this study, descriptive research design was employed, and in trying to address these issues, quantitative research method was used. In this study 72 students were chosen as a sample through stratified sampling technique. In order to achieve the objectives data gathering tools were used. These were conceptual understanding test (pre and post - test) on chemical bonding and intermolecular forces. The study indicated that the students had a lot of problems in understanding chemical bonding concepts. Pre-test given for sample students by dividing them into two (control and experimental) groups without any treatment. The score of the students in pre-test was similar and most them scored below 50% from both groups. Then after the researcher treated the experimental group by giving tutorial class and supportive additional time as well as laboratory activities for about six weeks. After six weeks the researcher gave for both groups post- test. The students who were treated in special way scored 50% and above most of them. But that of control group students also shown a change which was not relatively significant when compared to the experimental group.

In comparing the results of this research with those of the previous studies, this research supports most of the findings of the previous studies. For instance, as can be seen from the basic descriptive statistics of achievement scores, most of the students have misconceptions related to chemical bonding concepts. Moreover, the percentages of students' misconceptions are relatively similar to the results of previous studies [49]

The findings of this research were in agreement with that of studies that Learners under difficulties in identifying ionic bonding and covalent bonding concepts [49].

Moreover, in this study different categories of misconceptions were identified in detail in chemical bonding concepts, which supports the findings of the previous studies or in agreement with that of the studies that Learners confused in intermolecular and intramolecular forces [50].

5.2. Conclusions

There are some problems that Kutere Secondary School grade 9 students face, problem of understanding chemical bonding concepts. Previous knowledge and everyday language are main sources of misconceptions. Previous knowledge of students obtained from previous grades, from their peers, from different sources. Every day language which was commonly spoken ideas. Existing memories and information influence the learners' present learning. The identified misconceptions of students were minimized by giving extra time teaching students using tutorial classes, performing laboratory activities, using instructional materials, models and diagrams.

5.3. Recommendation

It is the concern of teachers and/or researchers to create conceptual understanding of chemical bonding concept students. This study states, identifying and minimizing of misconception of students in Kutere secondary school. Taking the findings of this study into account, the researcher has forwarded the following recommendations to the stakeholders:

1. For aiding students' conceptual understanding through instruction every educator should be aware of students' background, daily life experiences and differences in type of activities that has an important role on their preconceptions.

2. For promoting students' performance and positive attitudes in chemistry, teachers should encourage them to set meaningful learning goals and help students understand their attributions by creating both female and male oriented teaching instruction.

3. Teachers should spend more time to produce more conceptual talk about conceptually challenging topics that students describe their own views and ideas about a variety of phenomena.

4. The chemistry lessons should be organized to enable students' conceptual learning instead of rote learning and supplied with experiments and activities that student can perform and learn concepts by doing themselves.

5. Different instructional techniques are needed to apply by taking into consideration of students' misconceptions for gaining comprehension learning in chemistry.

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APPENDICES

APPENDICE I

WOLKITEUNIVERSITY

SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF CHEMISTRY

Conceptual understanding test about chemical bonding (pre-test)

The objective of this Conceptual understanding test is to collect information about students'misconcepti ons in chemical bonding. Since the reliability of the information depends on the objectivity of your responses, you are kindly requested to be as frank and honest as possible.

I. Personal information

Sex ….....Male……..... Female……. Age …….

Instructions

The test consist of 12questions (multiple choice items) please provide your responses by circling the letter that contains the correct concept multiple choice, if you come across with vague questions ask for clarification. Do not write your name finally, your answer remains strictly confidential and will not affect your class room results of chemistry.

Instruction:Choose the correct answer from the given alternatives

1. Ionic bond is formed by
   A/ sharing of electrons between metals and non-metals
   B/ electrostatic force of attraction between oppositely charged ions
   C/ delocalized electrons which are freely moving in the crystal lattice
   D/ transfer of electron from one atom of the element to the atom of the same element
2. Which electrons of an atom take part in bond formation?
   A/ outer most shell electronsC/ all electrons found in the atom
   B/ inner shell electronsD/localized electron
3. Potassium chloride (KCl) is soluble in water but in soluble in benzene. What is the reason?
   A/ since potassium chloride molecule is covalent compound it is soluble in polar solvent but insoluble in benzene
   B/ since benzene is non polar and KCl is ionic compound, therefore, it easily soluble in benzene

C/ since potassium chloride is ionic compound, ionic compounds are soluble in polar solvents, it is soluble in water.

D/since KCl molecule is ionic, it easily soluble in water

4. Covalent bond is formed by

   A/ The attraction of positively charged nuclei and the shared electrons in the molecule

   B/Only by sharing of electrons from the two atoms

   C/ Losing and gaining of electrons by to atoms

   D/ the attraction of the two nuclei of the bonding atoms

5. What is the fact that HCl is polar, Whereas Cl_2 is non – polar molecule?

   A/because there is an electronegativity difference between hydrogen and chlorine in the HCl molecule, HCl is polar

   B/ because of the electronegativity gap between chlorine atoms, CL_2 is non polar

   C/both of them are non- polar compounds

   D/ both of them are polar molecules

6. The type of intermolecular force that exist between water molecules is

   A/dipole-dipoleC/ London force

   B/ hydrogen bondingD/ Dispersion force

7. Is there any difference between pure covalent and coordinate covalent bonding?

   A/ Yes, pure covalent bond is formed by unequal sharing of electrons from both atoms but not in coordinate covalent bond

   B/ No, in pure covalent bond, the shared electrons originate from one of the bonded atoms

   C/yes, in coordinate covalent bonding the shared electrons are contributed from one of the bonding atoms

   D/ there is no difference between the two bonds

8. Identify the polar molecules from the following and explain

   A.HF B. CH_4 C. NH_3

   A/ HF and CH_4 are polar molecules because both of them contain hydrogen

   B/HF and NH_3 are polar molecules because they contain the most electronegative elements, F&N

   C/ CH_4 is the only polar molecule in the above because there is no electronegativity gap between carbon and hydrogenD/CH_4 and NH_3 are polar molecules because they contain hydrogen atom which is the symbol of polarity

9. The type of covalent bond formed by un equal sharing of bonding electrons is

A/ polar covalent bond C/ metallic bonding

B/ non-polar covalent bond D/ pure covalent bond

10. Is metallic bonding similar to ionic bonding?

A/Yes, it is similar to ionic bonding and formed between metals and non-metals

B/ No, it is a type of bond formed by the metals valence electrons which are freely moving and the positive nucleus of the metal

C/ Yes, both bonds are formed by transfer of electrons

D/No, metallic bonding is formed by sharing of electron but ionic bonding formed by transfer of electrons

11. Is there any difference between intermolecular forces and intramolecular forces?

A/ No, they both have similar feature

B/ Yes, intermolecular force is favored by molecules whereas intramolecular force favored between atoms

C/ Yes, intermolecular force can exist in both atoms and molecules

D/ yes, intermolecular forces occur between atoms, but intramolecular forces occur between molecules

12. Which of the following is true about covalent compounds?

A/ Covalent compounds conduct electricity in both solid state and in aqueous solution

B/ Covalent compounds do not conduct electricity in both states

C/ like ionic compounds, covalent compounds conduct electricity in molten state

D/covalent compounds relatively have high melting and boiling point

Prepared by: Chemistry Department in Kutere Secondary School

APPENDICES II

WOLKITEUNIVERSITY

SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF CHEMISTRY

Conceptual understanding test about chemical bonding (post-test)

I. Personal information

Sex …..... Male……....female…….. Age …….

Instruction

The test consist of 12 questions (multiple choice items) please provide your responses by circling the letter that contains the correct concept multiple choice, if you come across with vague questions ask for clarification. Do not write your name finally, your answer remains strictly confidential and will not affect your class room results of chemistry.

Instruction: Choose the correct answer from the given alternatives

1. The type of covalent bond formed by un equal sharing of bonding electrons is
   A/ polar covalent bond C/ metallic bonding
   B/ non-polar covalent bond D/ pure covalent bond
2. Is metallic bonding similar to ionic bonding?
   A/Yes, it is similar to ionic bonding and formed between metals and non-metals
   B/ No, it is a type of bond formed by the metals valence electrons which are freely moving and the positive nucleus of the metal
   C/ yes, both bonds are formed by transfer of electrons
   D/No, metallic bonding is formed by sharing of electron but ionic bonding formed by transfer of electrons
3. Is there any difference between intermolecular forces and intramolecular forces?
   A/ No, they both have similar feature
   B/ Yes, intermolecular force is favored by molecules whereas intramolecular force favored between atoms
   C/ Yes, intermolecular force can exist in both atoms and molecules
   D/ yes, intermolecular forces occur between atoms, but intramolecular forces occur between molecules

4. Which of the following is true about covalent compounds?

   A/ Covalent compounds conduct electricity in both solid state and in aqueous solution

   B/ Covalent compounds do not conduct electricity in both states

   C/ like ionic compounds, covalent compounds conduct electricity in molten state

   D/covalent compounds relatively have high melting and boiling points

5. What is the fact that HCl is polar; Whereas Cl_2 is non – polar molecule?

   A/because there is an electro negativity difference between hydrogen and chlorine in the HCl molecule, HCl is polar

   B/ because of the electro negativity gap between chlorine atoms, CL_2 is non polar

   C/both of them are non- polar compounds

   D/ both of them are polar molecules

6. The type of intermolecular force that exist between water molecules is

   A/dipole-dipole B/ hydrogen bonding C/Dispersion force

7. Is there any difference between pure covalent and coordinate covalent bonding?

   A/ Yes, pure covalent bond is formed by unequal sharing of electrons from both atoms but not in coordinate covalent bond

   B/ No, in pure covalent bond, the shared electrons originate from one of the bonded atoms

   C/yes, in coordinate covalent bonding the shared electrons are contributed from one of the bonding atoms

   D/ there is no difference between the two bonds

8. Identify the polar molecules from the following and explain

a. HF B. CH_4 C. NH_3

   A/ HF and CH_4 are polar molecules because both of them contain hydrogen

   B/HF and NH_3 are polar molecules because they contain the most electronegative elements, F&N

   C/ CH_4 is the only polar molecule in the above because there is no electronegativity gap between carbon and hydrogen

   D/CH_4 and NH_3 are polar molecules because they contain hydrogen atom which is the symbol of polarity

9. Ionic bond is formed by

   A/ sharing of electrons between metals and non-metals

   B/ electrostatic force of attraction between oppositely charged ions

   C/ delocalized electrons which are freely moving in the crystal lattice

   D/ transfer of electron from one atom of the element to the atom of the same element

10. Which electrons of an atom take part in bond formation?

    A/ outer most shell electrons

    B/ inner shell electrons

    C/ all electrons found in the atom

    D/localized electron

11. Potassium chloride (KCl) is soluble in water but in soluble in benzene. What is the reason?

    A/ since potassium chloride molecule is covalent compound it is soluble in polar solvent but insoluble in benzene

    B/ since benzene is non polar and KCl is ionic compound, therefore, it easily soluble in benzene

    C/ since potassium chloride is ionic compound, ionic compounds are soluble in polar solvents, it is soluble in water.

    D/since KCl molecule is ionic, it easily soluble in water

12. Covalent bond is formed by

    A/ The attraction of positively charged nuclei and the shared electrons in the molecule

    B/Only by sharing of electrons from the two atoms

    C/ Losing and gaining of electrons by to atoms

    D/ the attraction of the two nuclei of the bonding atoms

APPENDICES III

WOLKITEUNIVERSITY

SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF CHEMISTRY

INTERVIEW QUESTIONS

1. Students' conceptions on types of chemical bonding
   a/ how many types of chemical bonding are there?
   b/ what are they?
2. Students conception on bond formation
   a/ how ionic bond formed?
   b/ how covalent bond formed?
3. Students conceptions on general properties of ionic and covalent compounds
   a/ Can you mention the general properties of ionic compounds?
   b/ Can you mention the general properties of covalent compounds?
4. Students conceptions on solubility and conductivity of ionic and covalent compounds
   a/ are ionic compounds soluble in polar solvents?
   b/ what about covalent compounds?
5. Students conception on bond polarity
   a/ what is the different b/n polar and non polar molecules?
   b/ is water polar or non- polar? Why?
6. Students concept on intermolecular forces
   A/ is there any difference b/n chemical bonding and intermolecular forces?
   B/ mention the difference b/n intermolecular and intramolecular forces…