UNIVERSITY OF EDUCATION, WINNEBA

# MISCONCEPTIONS HELD BY FIRST YEAR GENERAL SCIENCE STUDENTS ABOUT THE CONCEPT 'SOLUTIONS': A CASE STUDY OF STUDENTS OF KETA SENIOR HIGH TECHNICAL SCHOOL, VOLTA REGION OF GHANA

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SETH BEDAI NARH

(7130130011)

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DECEMBER, 2015

# DECLARATION

**Student's Declaration**

I, **Seth BedaiNarh,** declare that this Dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature:……………………………

Date:…………………………………

**SUPERVISOR'S DECLARATION**

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Dissertation as laid down by the University of Education, Winneba.

**Name of Supervisor: …………………………………………..**

**Signature: …………………………………………………………**

**Date: ……………………………………………………………….**

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# DEDICATION

This dissertation is dedicated to my loving HEAVENLY FATHER whose amazing grace and mercy has brought me this far and all the Narh and Tsikata families.

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# LIST OF ABBREVIATIONS

A - Agree

D – Disagree

J.H.S- Junior High School

N.S – Not sure

R.P.K – Relevant Previous Knowledge

S.A – Strongly Agree

S.D – Strongly Disagree

S.H.S – Senior High School

T.L.M – Teaching and Learning Material

W.A.E.C – West African Examinations Council

# ABSTRACT

This study was aimed at unveiling and establishing the extent of misconceptions students held about the concept 'solutions'. The study used both qualitative and quantitative designs in a mixed Senior High School. The study involved one hundred and thirty-six participants. Data collection for the study was done using questionnaires, interview and the classroom observation. Analyses of the data from all three instruments revealed very similar findings. The study revealed that majority (60%) of the students held the misconception that alcohol in water was not a solution, 44.08% of the participants involved in the study were also of the view that a solution is only formed when a solid substance dissolves in a liquid . It was also revealed that the teacher(s) who taught the concept used an ineffective and traditional teaching approach which perhaps contributed to the misconceptions the students held. The results were interpreted using Descriptive statistics after the data analyses using Microsoft Excel. The findings indicated that due to the large extent of misconception held, this could affect the understanding of certain key concepts in the course of their study. This study has therefore made appropriate recommendations which when implemented could eliminate or reduce to the barest minimum the extent of misconception in future students of Keta Senior High Technical School.

# CHAPTER ONE

# INTRODUCTION

## 1.0 Overview

This chapter focuses on the background to the study, problem statement and justification, purpose of the study, research objectives, research questions, educational significance of the study, limitations and delimitations of the study.

## 1.1 Background to the Study

The study of solution has attracted the attention of many researchers who continuously focussed on different perspectives in the study of solutions and attempted to elicit students' views of the concepts involved. These views are presented as follows: (a) the dissolution concept (Novakowski, 2009;Calik and Ayas, 2005a) (b) the nature of solutions (Venille and Dawson, 2010); (c) solubility (Abell, 2007); (d) types of solutions (Çalik and Ayas, 2005b; Pinarbasi and Canpolat, 2003; Kaartinen and Kumpulainen, 2002; Kabapinar, Leach and Scott, 2004). The cited studies have attempted to answer several questions such as (a) what kinds of misconceptions do students have; (b) How common are the misconceptions; (c) how can these misconceptions be replaced with correct ideas; and (d) suggestions as to what teachers can do to improve teaching and learning environment that would reduce students' misconceptions. A number of terms have been used in these studies such as preconceptions, misconceptions, and alternative conceptions that students have and these terms also reflect some researchers' view of knowledge. That is, alternative conceptions fit ideas associated with constructivism, and misconceptions are associated with a positivist tendency (Taber, 2000). However, when these terms are used, they often convey a similar meaning (Costu and Ayas, 2005; Taber, 2000), but the use of the various terms help to describe students' confusion with the language and ideas of chemistry (Nicoll, 2001). In this study, the term 'misconception' is used to describe any prior knowledge students had which was different from or inconsistent with those accepted by the scientific community. Among the studies reviewed so far on solution chemistry, only Prieto, Blanco and Rodriguez (2002) reported that the examples given by some students were limited to particular solids that dissolved in given liquids. Prieto *et al*. (2002) further emphasised that students claimed that the solute was the most important component in the dissolution process and they described the solvent as a passive component. The study pointed out that only few students mentioned the interaction between a solute and a solvent, hence the meaning seemed to imply a chemical transformation.

As can be seen from the related literature, even though the cited studies on solution chemistry have concentrated on different perspectives, there appears to be a poor knowledge of what students understand about the terms 'solution', 'solute' and 'solvent', whether they are able to apply theoretical knowledge to novel situations, whether the students are able to make connections between school and real life experiences, and how the instructions that students receive influence their thoughts.

**1.2 Problem statement**

The concept of 'solution' has been misunderstood by many students in our Senior High Schools including first year science students of Keta Senior High Technical School.

It was noted that majority of students could not describe how solutions are prepared from a solute and a solvent during the Integrated Science paper of the May/June 2006 West Africa Senior Secondary Certificate Examination (W.A.E.C, 2006 Chief Examiner's Report). Few of them however were able to state the types of solutions.

Again, some class interaction with sampled students of different cognitive levels revealed their inability to identify a solid-solid solution and wondered how this type of solution was possible.

It is therefore justified from the above concerns to unveil some misconceptions students have in learning the science concept 'constituents of a solution', investigate their sources of misconception and suggest some remedies in handling these misconceptions when they arise in the classroom.

## 1.3 Purpose of the study

The purpose of the study was to help unveil some misconceptions students have in the study of solutions and their constituents as stated in the Chemistry syllabus developed for teaching and learning by the Ministry of Education for all Senior High Schools. In addition, the study was designed to make various recommendations for Chemistry teachers in the teaching of the concept under study, curriculum developers in education and the Ministry of Education.

The study may also serve as a useful source of information for further research in science education.

## 1.4 Research Objectives

The following were the specific objectives of the study;

To elicit some misconceptions first year science students of Keta Senior High Technical School have about the concept ‘solution’.

To determine the sources of the misconceptions.

To suggest remedies in dealing with misconceptions on the concept when they arise in the classroom.

## 1.5 Research Questions

The following questions guided the research;

What misconception do first year science students of Keta Senior High Technical School have about the concept ‘solutions and their constituents’?

Where do these misconceptions emanate from?

What teaching approach (es) do teachers use whilst teaching the concept under study?

## 1.6 Educational significance of the study

Solutions and their constituents is one of the most important topics in Chemistry. Constituents of a solution inform students about the various types of solutions and how to prepare them. In addition, the understanding of solutions and their constituents facilitates the understanding of how acid-base indicators work and how to identify ions in solutions. For example, students have to distinguish between various indicators used in the laboratory before performing a certain titration task in their attempt to find out what volume of the acid solution reacted with a base.

Moreover, misconceptions about solutions are hindrances to the learning of new concepts. It is therefore necessary to identify students' misconceptions about solutions and their constituents for an instructor to help his/her students understand the scientific concepts properly.

Teachers and all other instructors can use the findings in this study in their lesson delivery. Above all, curriculum developers can also make use of the outcome of the study in developing relevant curriculum for schools.

## 1.7 Limitation of the study

A broader survey would have clarified to a large extent the findings made in this study. However, time and cost constraints prevented the inclusion of other similar educational institutions into this study. The results of the study therefore are only strictly applicable to first year General Science students in Keta Senior High Technical School.

## 1.8 Delimitation of the study

The study was delimited to only the first year General Science students of Keta Senior High Technical School on the concept 'solutions and their constituents' as a result of time constraint and their proximity to the researcher.

# CHAPTER TWO

## LITERATURE REVIEW

### 2.0 Overview

This chapter discusses the available literature related to this study. It is grouped under the following headings: Concept and concept learning, Types of Concept, Factors affecting concept learning, Misconceptions, Identifying misconceptions, Solutions and their constituents.

### 2.1 Concept and Concept learning

According to Zohar (2006), people argue their opinions by way of words, images, signs, symbols and concepts. The study further explains that science concepts are the symbols and knowledge representing concrete objects and/or abstract ideas in nature.

Concepts are mental representations that, in their simplest form, can be expressed by a single word, such as plant or animal (Carey, 2000). Carey further states that two concepts could be combined to form another totally different structure. For example the concept "density" which is "mass per unit volume" is a product of two concept words despite the fact that it stands on its own. Some concepts are even more complex and can describe a whole idea, for example the theory of the discovery of the atom. Concepts can thus act like building blocks of more complex representations.

Learners continually put old learnt concepts to use and in the process usually extend them to acquire new but related ones (Blaxter, Hughes and Tight, 2006). Concepts can be learnt intentionally or not.

Learning of concepts in the cognitive structure is not entirely a result of direct observation and or past experience but cognitive process such as organization, interpretation and combination of thoughts play a major role.

Abdi (2006) contends that concepts can be formed with or without verbal presentations. For Abdi (2006), concepts are learnt in stages and not at a go. The student learns the representative image of the concept and later in life learns the verbal representations. In view of the above it is therefore important learners made the correct ideas of the concepts.

Perhaps the most important function of concept is cognitive economy (Abell, 2008). If there were no concepts, we would have to learn and recall the word that represents each item in our world. For example each type of tree or automobile would need its own name in order to communicate about it in a meaningful way. Posnanski (2000) argues that the size of our mental vocabulary would be so large that communication would be almost impossible, if not totally impossible.

Ziribel (2001) however opined that learning is a mental process that depend on perception, awareness and how new ideas get integrated into the old one; a process called ‘assimilation’. The study observed that addition of new information is the first part of learning and thus the entire learning process involves the integration, re-organization and the creation of new mental structures. All concepts however have names or labels and more or less exact definitions which permit mutual understanding and communication with others using concepts.

It is worth noting that students do not come into the classroom as “blank slates” but come to class with already preconceived ideas on various topics. Richmond and Mamokore (2011) found out that students have their own individual knowledge, beliefs and ways of thinking about a concept. Sometimes these views may rather be strange and difficult to let go off them.

Ziribel (2001) contends in a study that a person has asset of intellectual abilities and has developed specific ways of thinking, speaking and even how to read. As to how much of this material is accessible is another issue for investigation. The study further posited that learners’ experiences have determined how their brains got hardwired and the type of specific skills students possessed. This is to mean if new information is fed into the brain and a thinking network already exists, the student feels more at ease and will more readily be able to follow certain arguments. This is even more difficult if a student is made to think in an unfamiliar fashion. This requires the changing or in other words the abandoning of the original hardwiring but with a lot more effort from the end of the student this can be done. The instructor therefore has to reconfigure or even create some of the thinking networks.

Similar findings were reported by Le Doux (1999) where the study added that, whenever a learner experiences something new, the brain searches for an existing network into which to fit that information, and if this network is found, the brain processes and evaluates the information relatively easier, but if not, additional connections have to be made.

From the review above, it can be deduced that the ability to form science concepts depend upon the learner's own background and the conditions under which teaching and learning is done.

Concepts are most often acquired when familiar or concrete materials are used. To this end, Le Doux (1999) investigated the influence of the conditions under which teacher trainees learn science concepts.

## 2.2 Types of Concepts

Sternberge and Ben-Zeev (2001) revealed the presence of at least five types of concepts. These are: Concrete, abstract, verbal, non-verbal and process concepts.

The study argued that concrete concepts are those that can be seen, touched or heard. Example includes furniture. The concept under study also falls in this category of concept types. Abstract concepts are thought to have no sensory input unless analogy is used. The study further explained that verbal concepts are often thought of as group of ideas that are best understood using language. Example includes friendship. Non-verbal concepts are often thought to be best understood by making pictures to represent their critical attributes. This is often known as visualization. Examples of non-verbal concept include perimeter and area. Process concept represents mechanisms such as chemical reactions. It is interesting however to note that the different types of concepts overlap (Richards and Schmidt, 2002).

Concepts exists in two kinds; empirical and theoretical. Intensive studies made in this area of research contend that empirical concepts are those that are observable or can be demonstrated. They can also be relatively measured. Examples include diffusion, freezing and volume. Theoretical concepts however are non-observable and are not measured directly. An example is an atom. It was therefore important that the study investigated the hindrances that impeded the learners from grasping and applying concepts such as solution and devised strategies that could be used to help the students to grasp these concepts. Since every individual builds up his or her world on concepts, they cannot be under estimated.

### 2.3 Factors affecting Concept learning

Learners have difficulty in understanding scientific concepts because they do not have the necessary conceptual background (Abell, 2007). Environmental characteristics that determine a student is by the upbringing. The language and culture certainly affects his way of thinking. Parents, mentors and interactions also affect his character and might influence his personal beliefs. Various means of culture, social and culture interactions occur during concept formation (Supovitz and Turner, 2000).

The use of language also impacts on the formation of concepts. Supovitz and Turner (2000) however argues that the complexity of the composition of the learners' thought needs to be rearranged and also that the socio-culture environment needs to be adopted to favour both the teacher and student beliefs about the teaching and learning of the concept. It was therefore very important the study investigated the extent to which language impacts on the formation of science concepts by students. This is very important since the medium of instruction in the Senior High Schools in Ghana is English Language which is not the first language of the learner but however needs to have control over the English Language in order to articulate their views.

Duit (2009) also explained that much of the concepts learnt in schools are based on the curriculum of the school programme. Students face a wide range of problems to be tackled, however not all are found in the science textbooks. Solving problems sometimes require using the products of other areas of higher order cognition such as concepts.

## 2.4 Misconceptions

According to Gomez-Zweip (2008), a misconception is defined as scientifically incorrect interpretation and responses to problems that may be provided. However, many studies referred to misconceptions differently like preconception or children's science (Duit and Treagust, 2003). None the less, the extensive research on misconceptions has also focused on characteristics, sources and identification of misconceptions. For instance, Keeley, Eberle and Dorsey (2008) describe the three main ways students acquire misconceptions from nature, language, and from instruction.

Keeley *et al*. (2008) referred to misconceptions from nature as life experiences like touching and observing objects therefore constructing some naive concept based on that. The paper further explained that misconceptions from language emanate from the science text books used, adults, through idiomatic expressions which when used mean something differently from the original context. With regard to instruction, the studies referred to what students learn as part of their formal education in classroom. For example, if an instruction is limited to only one or two contexts, it may not be good enough to outwit any preconceived idea(s) students bring into the classroom so the student keeps the earlier conceptual framework. Sometimes, the case might only be that a concept is introduced either before a student is cognitively matured to understand the idea behind it or the explanation is simply at a level that is too high for understanding.

Other studies also revealed several sources of misconceptions (Gronlund, 2003; Pruitt and Wallace, 2012).

Although the students' misconceptions are often naive, they often have strong explanatory power to the student (Bahar, 2003).

Misconceptions however are pervasive and resistant to change. Student misconceptions in science courses have been addressed by numerous authors (Wilson, 2001; Keeley, Eberle and Farrin, 2005; Jonassen, 2008;).

Shuttleworth (2008), found out that most scientific education curricula and many scientists study how to do experiments, but without the understanding of why, and the basic underlying processes defining the very nature of science. Research has shown that even science teachers have some misconceptions about some science concepts (Keeley *et al*., 2007, Burgoon, Heddle and Duran, 2010)

The nature of the source of misconception determines how easier or difficult it is to change (Gillham, 2000). Students therefore hold many misconceptions that should be identified appropriately before instruction so as to aid remediation during instruction.

**2.5 Identifying misconceptions**

Many studies have attempted identifying misconceptions learners have when learning science concepts (Kang, Scharmann and Noh, 2004). Instructors, this notwithstanding have invested very little time or no time at all in finding out exactly what the students know or what they do not know and even what they might be confused about (Pinarbasi and Canoplat, 2003; National Research Council, 2005). Identifying what students know already before a lesson would help among other things in preventing wastage of precious time or even over indulgence on the part of the teacher. It is for this reason that the guidelines for writing a lesson notes includes the relevant previous knowledge (R.P.K) of the learners prior to instruction. Since learners bring to the class their preconceptions which may be wrong, identification of prior knowledge is an important part of instruction for meaningful learning (Morrison and Lederman, 2003). Studies have established various means by which misconceptions can be identified. These include interviews, concept mapping, open-ended questionnaires, multiple- choice test and two or three tier diagnostic test. Most researchers whose works have been reviewed in this study have used the interview technique to identify many misconceptions in some science concepts (Cetin, 2003; Diakidoy and Iordanou, 2003; Clement, 2008).

## 2.6 SOLUTIONS AND THEIR CONSTITUENTS

According to the American Royal Chemical Society, a solution is a homogeneousmixturecomposed of two or more substances. In such a mixture, a solute is a substance dissolved in another substance known as a solvent. The solution more or less takes on the characteristics of the solvent including its phase and the solvent is commonly the major constituent of the mixture. The concentration of a solute in a solution is a measure of how much of that solute is dissolved in the solvent, with regard to how much solvent is available (Chi, 2005).

Homogeneous means that the components of the mixture form a single phase. Heterogeneous means that the components of the mixture are of different phases. The properties of the mixture such as concentration and density can be evenly distributed throughout the volume (Brown, 2001). Usually, the substance present in the greatest amount is considered the solvent. Solvents can be gases, liquids or solids. One or more constituents present in the solution other than the solvent are called solutes. The solution has the samephysical state as the solvent.

### 2.6.1 Gaseous solutions

If the solvent is a gas, only gases are dissolved under a given set of conditions. An example of a gaseous solution isair which is a mixture of oxygen and other gases dissolved in nitrogen). However, a study conducted on one hundred and twenty high school students in the United Kingdom by Pruitt and Wallace, 2012 revealed that some students were naive to gaseous solutions since they argued that a solution was always in a liquid state. Since interactions between molecules play almost no role, dilute gases form rather trivial solutions. In part of the literature, they are not even classified as solutions, but addressed as mixtures.

### 2.6.2 Liquid solutions

If the solvent is a liquid, then almost all gases, liquids and solids can be dissolved. Some examples of say a gas in liquid solutions include carbon dioxide in water – a less simple example, because the solution is accompanied by a chemical reaction (Treagust, 2014). It must be noted also that the visible bubbles in carbonated drinks such as ‘Coca-Cola’ are not the dissolved gases, but only an effervescenceof carbon dioxide that has come out of solution; the dissolved gas itself is not visible since it is dissolved on a molecular level.

For liquid in liquid solutions, they include the mixing of two or more substances of the same nature but different concentrations. For example alcoholic beverages are basically solutions of ethanol in water.

Solid in liquid solutions are probably the most common and easily identified type of solutions. Research indicate that majority (98%) of students in high schools in South America know of this type of solution. An example of this solution is sucrose (granulated sugar) in water, sodium chloride (NaCl) (tablesalt) or any othersalt in water, which forms an electrolyte: The salt dissolves into its own ions.

Counterexamples are liquid mixtures that are not homogeneous: colloids, suspensions, emulsions are not considered solutions.

Body fluids are examples for complex liquid solutions, containing many solutes. Many of these are electrolytes, since they contain solute ions, such as potassium (Nunan, 1999). Furthermore, they contain solute molecules like sugar and urea. Oxygen and carbon dioxide are also essential components of blood chemistry, where significant changes in their concentrations may be a sign of severe illness or injury.

### 2.6.3 Solid solutions

If the solvent is a solid, then gases, liquids and solids can be dissolved.

Gas in solids solutions can be observed when hydrogen dissolves rather well in metals, especially in palladium; this is studied as a means of hydrogen storage.

Liquid in solid solutions include mercury in gold, forming an amalgam, Hexane which is liquid at room temperature also dissolves in paraffin wax

Solid in solid solutions include steel, which is basically a solution of carbon atoms in a crystalline matrix of iron atoms, alloys like bronze and many others.

Solution chemistry is an important subject area in which both students and teachers have common misconceptions (Ebenezer, 2001, Pinarbasi and Canpolat, 2003). Conceptual understanding of the terms used in the subject area such as 'solute', 'solvent' and 'solution' is significant since other areas depend on the understanding of the concepts. The study conducted by Nicoll (2001) revealed that many prospective science teachers used in the study could not learn the concepts related to solutions well enough. The findings showed that teaching methods, memorization of the terms, making science lessons without laboratory works, insufficient curriculum and traditional learning activities could be the reasons for the poor output of the teachers. The study concluded that the results implied that more effective teaching strategies need to be developed to prevent misconceptions about the subject. If the science teachers had some misconceptions about solution chemistry, then their students could be faced with difficulties in problem solving.

From the findings of Calik and Ayas (2005a), it showed that students had difficulties describing and using the terms 'solution', 'solvent' and 'solute'. Solvay (1999) maintained in his study that the various types of knowledge exist in the cognitive system of children and compete with acquired knowledge which may be available in the cognitive system. The findings made by Calik and Ayas (2005a) indicated that even though some students in the sample population had an accurate understanding of chemical processes the study anticipated that their knowledge of solubility concepts should have been at its maximum. It was however revealed from the study that students' misconception about solubility even outweighed their knowledge on the chemical processes. Some of the students in the study conducted by Calik and Ayas (2005a) confused both solute and solvent concepts with information concerning liquids and solids. This may be due to the instructions their teachers administered since teachers are the chief source of instruction in the educational context. Students in the lower grades in the study implied that sugar and water were both solute and solvent. They argued that at the beginning of this process, both of them were solvents and then changed into solutes. This is a clear indication that students in the lower grades were not able to distinguish between solutes and solvents. Moreover, some of the students in the upper grades claimed that when a cube sugar is put into a beaker which contains water, a chemical reaction takes place. This may also be a source of confusion for the study of the concepts 'hydration' and 'hydrolysis'.

The study conducted by Kang *et al*. (2004) revealed that there existed a significant correlation between cognitive conflict and conceptual change from the analysis of a t-test result. Meaningful learning approach however was found to have no statistically significant effect on cognitive conflict. It is worth noting that the terms 'solute, 'solvent' and 'solution' could be confusing and thus requires a deliberate attempt by teachers to set some level of cognitive conflict in the minds of the students so as to achieve the needed conceptual change. Many studies on conceptual change have focused on specifically designed strategies employing a cognitive approach on the basis of the model. A cognitive conflict strategy emphasizes destabilizing students' confidence in their existing conceptions through contradictory experiences and then enabling students to replace their inaccurate preconceptions with scientifically accepted conception (Limon, 2001)

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.0 Overview

This chapter is devoted to the Design of the Study, Study Area, Research Population, Research Instruments, Data Collection, Sampling and Sampling Procedure, Description of the Questionnaire items and scoring the Questionnaire items. It further entails the credibility of the main instrument, procedure and rationale for data analysis.

## 3.1 Design of the study

A case study design was used in this study since the researcher wanted to have an in-depth study into the problem at hand.

The study was both qualitative and quantitative research design. The entire population was used since random sampling in this peculiar case of a concept taught only to the General Science students in Keta Senior High Technical School would have produced biased data. Also, using the whole class rather than a random sampling would give the researcher an in-depth knowledge of the extent to which the concept is misconceived so as to suggest appropriate remedies to the problem and also fulfill the actual purpose of the study.

## 3.2 Study Area

Keta Senior High Technical School is one of the nine public Senior High Schools in the Keta Municipality of the Volta region of Ghana. The school provides educational opportunity for people far and nearKeta. The school lies within longitudes $0.30^0$ East and $1.05^0$ East and latitudes $5.45^0$ North and $6.01^0$ North and located about 160 km to the East of Accra. The school shares borders to the east with sister schools namely Keta Business Senior High School, Anlo Senior High School and the Zion College; to the west of the school is the Keta Municipal Assembly. The school's student population stood at two thousand four hundred and fifteen (2415) as at the end of 2014/2015 academic year with 105 teachers. Programs offered by the school include General Science, Business, General Arts, Agricultural Science, Home Economics, Visual Arts and Technical. The school however is known for her exceptional performance in Science related competitions.

### 3.3 Research Population

The target population for this study was all first year General Science students of the Keta Senior High Technical School in the Volta Region of Ghana with a total population of one hundred and ninety–three (193) comprising 125 males and 68 females. However the accessible population was only first year General Science students of forms 1'A' and 'B' classes with a total population of one hundred and thirty-six (136) since students of the third class in the target population were on a week's assignment which could not be interrupted.

The school however was used in this study because of its proximity to the researcher who is a member of the teaching staff in the school.

### 3.4 Research Instruments

The main instrument for this study was the questionnaire. This was supplemented by classroom lesson observation and interviews. These were done to triangulate the data to obtain reliable results for the study.

### 3.5 Data Collection

Data for this study was collected using the questionnaire, classroom observation and interview of ten sampled respondents. The questionnaire which was the main instrument for the data collection was carefully written so that the short comings associated with collecting data using this instrument were minimized. The questionnaire was pilot tested on a near-by school. Prior to the data collection, exactly on the Friday, $11^{th}$ September, 2015, the researcher wrote a letter to the head of the institution where the study was to take place seeking approval to use some contact hours to collect data on the concept under study. The request was granted on the $15^{th}$ September, 2015 paving the way for the commencement of the data collection. The researcher upon approval of the request informed the target population soliciting their consent and cooperation for the study. Questionnaires are undoubtedly one of the primary sources of eliciting responses in any research endeavor (Muijs, 2004). Data Collection by questionnaires began with the first class on the $17^{th}$ September, 2015. Questionnaires were administered to the respondents, which were duly completed and submitted within a maximum of forty minutes. The researcher ensured all questionnaires administered were collected. Data collection by questionnaire continued when the researcher administered the questionnaires to the second class which was also successfully completed and submitted within a maximum of thirty-five minutes. In order to avoid the Hawthorne effect in research, the data collection was done on the same day so as to minimize influences of each other's responses.

The classroom observation of a lesson on the concept under study taught by another Science teacher was done three clear days after the completion of the data collection by questionnaire. The researcher sat at the back of the class with some students. The researcher observed the students and their activities in addition to the activities performed by the teacher. The broad focus style where one focuses on the entire classroom activities during the lesson observation was employed. In order not to be biased, the researcher remained aloof and did not participate in the activities that went on during the lesson. The initial discomfort students had due to the researcher's presence in the classroom decreased significantly after the researcher observed for a while. This was evident in the way students began to ask questions exposing their misconceptions. The researcher recorded the observations in the observation schedule sheet in Appendix C. The recording of the observations made was done at most for an interval of four minutes. This in total made up to about ten observations since it was done in a period of forty minutes.

To further triangulate the data, an unstructured interview style was adopted to collect data on the misconception about the concept under study. Since it was almost impossible in this case to interview all the 136 students, a random sampling technique was used to sample ten students who were interviewed. The unstructured interview was recorded on a tape for proper analyses of the data obtained. Each interview lasted between two to four minutes for each interviewee.

### 3.6 Sampling and Sampling Procedure

Lawrenz (2001) defined a sample as a smaller group that researchers focus on. Sampling is done to obtain a representative of the larger population.

The purposive sampling technique method was partially used in selecting the sample population for the study. In this study all the one hundred and ninety-three first year General Science students were targeted to be used. A simple random sampling technique was used to select the students who were interviewed. In doing the simple random sampling of the students to be interviewed, numbers from 1 to 136 were written on pieces of papers and placed in a box. The numbers were picked by all students, however only students who picked the first ten consecutive numbers, that is from 1 to 10 were selected for interview. The 10 students who were sampled for the interview comprised of 6 males and 4 females.

### 3.7 Description of the Questionnaire items

The questionnaire began with information assuring students of the confidentiality and anonymity of their responses.

The questionnaire consists of two (2) main sections (A and B). Section (A) contains three items that elicited information on the demographic or bio data of the participants. The variables in section A covered respondents' gender, age and type of Junior High School attended. These data were in tune with the purpose of this research since the respondents' gender, age and the type of Junior High School attended might have significant influence on their perceptions about solutions and their constituents.

The second section, B consists of thirteen (13) items (i.e. items 4 – 16) that elicited information on respondents' perception of the concept 'solutions and their constituents', the sources of these perceptions, how teachers handled students' confusion during the lesson on 'constituents of a solution', the kind of teaching and learning materials (TLMs) employed in teaching the concept and the teaching approach(es) used. However, for items that did not have the responses provided for respondents to choose from, an opportunity was given for respondents to write their own responses.

### 3.7.1 Scoring the questionnaire items

A Likert scale with five options (Strongly Agree, Agree, Not sure, Disagree and Strongly Disagree) was used to score the questionnaire items 4 to 7. The items on the questionnaire were both negatively and positively worded. Negative worded items (e.g. "A solution is only formed when a solid substance dissolves in a liquid") were scored as follows:

| Response Intensity | Symbol | Score |
|---|---|---|
| Strongly Agree | SA | 1 |
| Agree | A | 2 |
| Not Sure | NS | 3 |
| Disagree | D | 4 |
| Strongly Agree | SD | 5 |

Likert scale was used to score the questionnaire items because it looks interesting to respondents and people often enjoy completing a scale of this type (Muijs, 2004). Again, Likert scale is easier to construct, interpret and also provide the opportunity to compute frequencies and percentages as well as statistics such as the mean and standard deviation of scores.

**3.8 Credibility**

The main instrument used in the investigation was sent to the supervisor who has scholarly opinion about the formation of concepts in sciences and their sources. The supervisor carefully scrutinized the test items, discarded the invalid ones and suggested correct ones. The suitability of the instrument was also discussed with Professor John Eminah of the Department of Science Education in the Faculty of Science Education of the University of Education, Winneba who also provided some valuable assistance in the organization of the test items.

**3.9 Procedure and Rationale for Data Analysis**

The procedure for data analysis was based on the nature of responses to the test items. The single frequency count statistical analysis was used to compile the recurrence of the responses to the test items. The number of respondents who chose each response to an item in the questionnaire were counted and recorded. The responses were analyzed using both qualitative and quantitative strategies such as categorization, interpretation, noting patterns and clustering of beliefs and values. The researcher entered the responses of the items on each of the one hundred and thirty (130) useable questionnaires into the Microsoft excel software which expressed the single frequency counts into percentages as shown in the results and discussions.

The researcher sought to find out the following:

Establish the extent of misconception first year science students of Keta Senior High School have about the concept as covered by the test items.

Identify the sources of these misconceptions

What teaching approach(es) do teachers use whilst teaching the concept under study?

# CHAPTER FOUR

# RESULTS AND DISCUSSIONS

## 4.0 Overview

In this chapter, the findings from the investigation into the extent of students' misconception about the concept 'solutions and their constituents' are presented and discussed in relation to the three research questions. The research questions are discussed with the help of qualitative descriptive statistical tool as well as the responses from questionnaire for the students. The findings of the study are discussed based on the research questions of the study.

## 4.1 Research Question One (1)

What misconception(s) do first year science students of Keta Senior High Technical School have about the concept 'solutions and their constituents'?

### 4.1.1 Analyses from Questionnaire Data

Responses of students on items 6, 7, 8 and 9 of the questionnaire found in Appendix A were used to establish the extent of misconceptions these students have about the concept 'solution and their constituents'. This was further buttressed during the interview conducted on some ten randomly selected first year science students. The misconceptions students held were reinforced by an observed lesson on the concept under study.

Table 1 summarizes the results for item 6 as set out in the questionnaire. These results were an aggregation of responses for the said item provided in the useable questionnaires.

Table 1: Respondents' responses and frequency distribution to item 6 of the questionnaire.

| Responses | Frequency | Percentage (%) |
|---|---|---|
| Strongly agree | 24 | 18.46 |
| Agree | 22 | 16.92 |
| Not sure | 10 | 7.69 |
| Disagree | 27 | 20.77 |
| Strongly disagree | 47 | 36.15 |
| **Total** | **130** | **100.00** |

The bar chart below represents the results obtained after a careful analysis of the responses provided for the aforementioned item on the questionnaire.

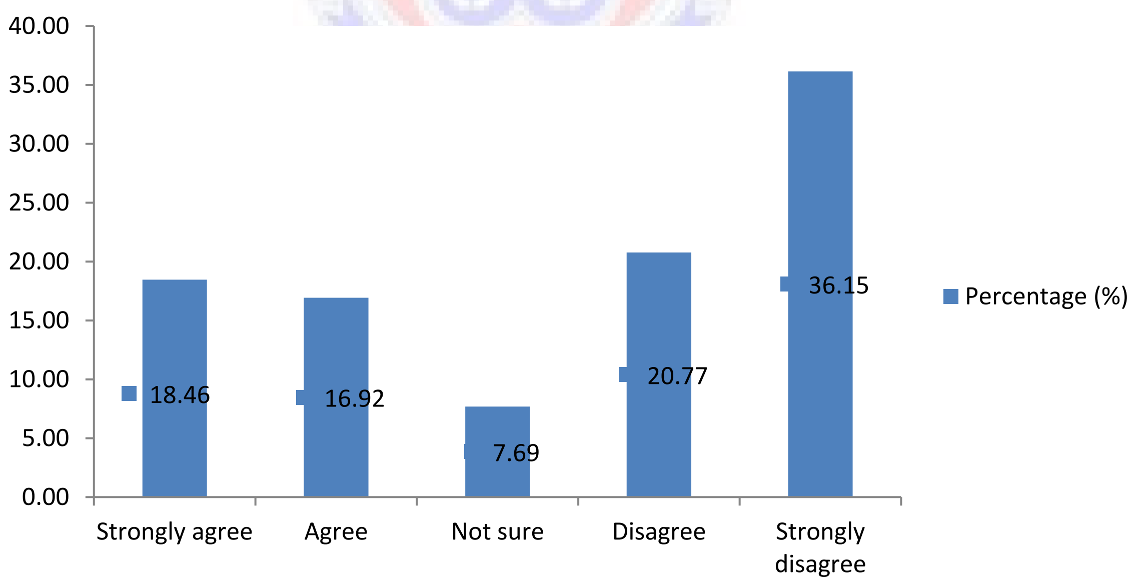


**Figure 1: Bar chart showing analyzed results of respondents' responses to item 6 of questionnaire.**

The results of the study revealed that although a significant number of the students representing 36.15 % strongly disagreed with the statement in item 6 with a slightly lower percentage of 20.77 % of the respondents disagreeing to the same statement, a significant number of students; that is those who agree (fifty-six out of one hundred and thirty) representing a percentage of 44.08% agreed to a large extent that 'a solution is only formed when a solid substance dissolves in a liquid'. This opinion held by the students is not only wrong but could have the potential of delaying the facilitation of knowledge acquisition about the concept under study (Eggen and Kanchak, 2004).

Table 2 shows the summary of results of respondents' responses to item 7 on the questionnaire.

| **Response** | **Frequency** | **Percentage (%)** |
|---|---|---|
| Strongly agree | 10 | 7.69 |
| Agree | 27 | 20.77 |
| Not sure | 30 | 23.08 |
| Disagree | 27 | 20.77 |
| Strongly disagree | 36 | 27.69 |
| **Total** | **130** | **100.00** |

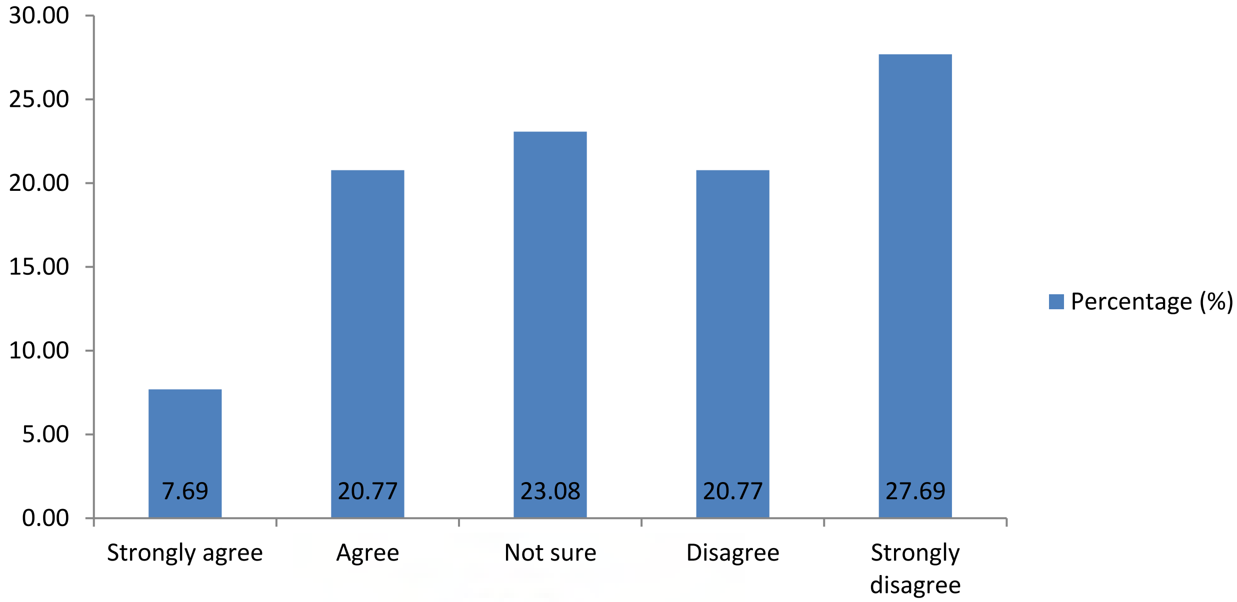


**Figure 2: A bar chart showing respondents' responses to item 7 of the questionnaire.**

A significant percentage (28.46%) of the respondents however admitted that the concept ‘solutions and their constituents’ is very confusing. This admission made by the students is very welcoming since it would lead to the overhauling of the teaching and learning process with respect to the concept under study. Again, it tells clearly the extent to which students hold misconceptions about the concept.

Table 3 below shows the aggregated results of respondents' responses to item 8 on the questionnaire.

| **Response** | **Frequency** | **Percentage (%)** |
|---|---|---|
| Salt in water | 2 | 1.54 |
| Alcohol in water | 78 | 60.00 |
| Sugar in water | 1 | 0.77 |
| None of the above | 49 | 37.69 |
| **Total** | **130** | **100.00** |

Figure 3 below shows a graph of respondents' responses against their percentages for item 8 of the questionnaire.

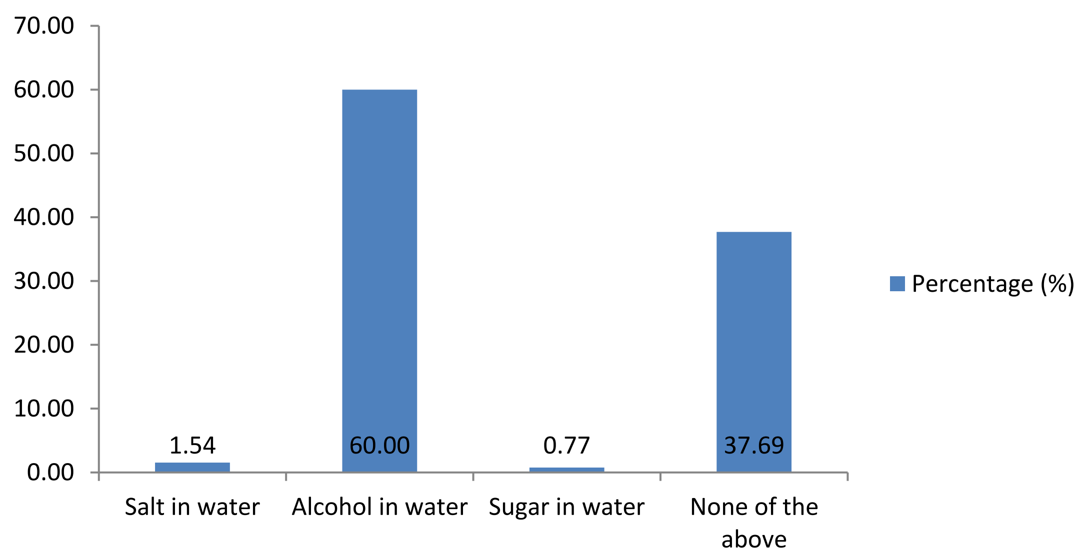


**Fig 3: Graph showing respondents' responses against their percentages for item 8 of questionnaire.**

With respect to item 8 which sought to find out if students could identify solutions from examples made, a whopping 60 % of the students were of the view that alcohol in water was not a solution. This probably could be because they could not comprehend how two liquids could form solutions. Only a hand full of the students (37.69 %) was able to notice that the list provided had none of the responses being solutions. This results obtained from the questionnaire data administered clearly unveils the extent to which science students misunderstood the concept despite their positive response to item 4 of the questionnaire.

Table 4 below shows the representation of respondents' responses to item 9 after a careful analysis of the questionnaire used.

| Response | Frequency | Percentage (%) |
|---|---|---|
| Gari in water | 13 | 10.00 |
| Powdered chalk in water | 36 | 27.69 |
| Steel | 41 | 31.54 |
| None of the above | 40 | 30.77 |
| **Total** | **130** | **100.00** |

The chart below shows therespondents' responses and percentage of respondents to item 9 after a careful analysis of the questionnaire used.

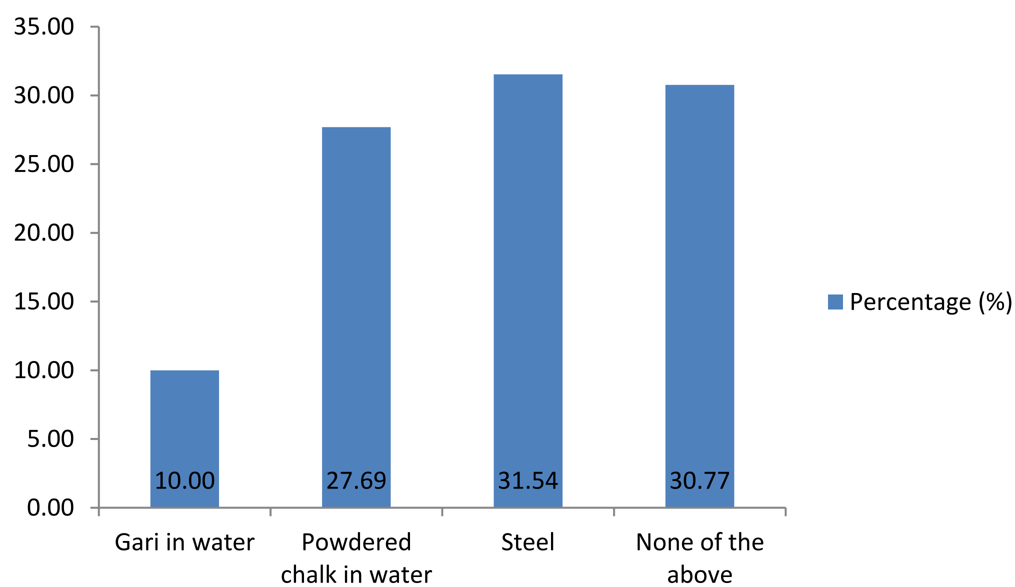


**Fig. 4: A graph showing the pattern of respondents' responses to item 9 after a careful analysis of the questionnaire used.**

The results obtained for item 9, was only to reaffirm that the students to a large extent hold several misconceptions about the concept which needs to be address. It is worrying to note that only 31.54 % of the students recognized steel as a solution whilst the large population of students (a little over 68%) could not identify the solution. This probably could mean they doubted how solids can form solutions. It is even much worrying to have some respondents arguing that gari in water is a solution. Could it be that these students do not know the characteristics of a solution?

### 4.1.2 Analyses from Classroom Observation

During the classroom observation as the concept was taught, the researcher observed that students asked questions that clearly indicated that they have been misinformed about the concept under study. Questions such as "Can two solids form solutions?", "How do two solids form solution?" and "Are solvents used in solution always water?" These were further compounded when the teacher asked students to define the term 'solution'. Answers provided were far from the right answer students were to give. A significant number of a class of sixty-eight students hold the view that a solution is a uniform mixture of a solute and a solvent where the solute is always a solid whilst the solvent always water. Interestingly, students forgot that water is not the only liquid in which solids can dissolve and that not all solids dissolve in water. The facial expression of the students when the teacher stated that a bottle of carbonated drink is a solution was a confirmation that students did not understand the lesson taught.

### 4.1.3 Analyses from Interview

The interview instrument was also effective in bringing out the misconceptions students held about the concept under study. Out of a randomly selected ten students for the study, only two of them were able to recognize the unique characteristic of a solution; that is the fact that solutions are composed of only one phase. However, these two students fail to recognize that alloys are also solid solutions when asked if brass is a solution. They argued that solution must always be in the liquid state.

The findings revealed in this study from all the three instruments are in tune with those of Prieto*et al*. (2003); Calik and Ayas, 2005a who reported similar findings when they studied the extent of misconception among children of different ages about the dissolution concept of solutions.

## 4.2 Research Question Two (2)

Where do these misconceptions emanate from?

All three research instruments were used to collect data to answer the research questions.

Items 10 and 11 of the questionnaire found in Appendix A were used to establish the sources of the identified misconception.

The table below shows the summary of responses gathered from all 130 useable questionnaires.

Table 5: Respondents' responses on where they learnt the concept from

| Response | Frequency | Percentage (%) |
|---|---|---|
| Books only | 14 | 10.77 |
| School lessons only | 29 | 22.31 |
| Peers/friends only | 1 | 0.77 |
| Others only | 1 | 0.77 |
| Both books and School lesson | 85 | 65.38 |
| **Total** | **130** | **100.00** |

The bar chart below clearly describes the distribution of the responses provided by respondents with respect to item 10 of the questionnaire data.

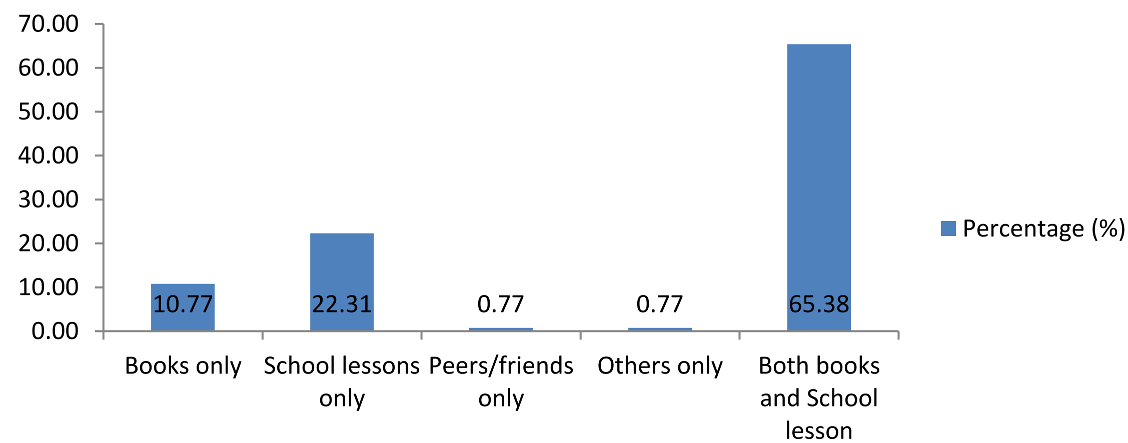


**Figure 5: Graph showing the frequency distribution of respondents' responses on where they learnt the concept from**

### 4.2.1 Analyses of Questionnaire Data

The research revealed that an overwhelming 65.38 % of the respondents noted that they learnt about the concept from both books and school lessons. It can be inferred from the data that most of the respondents held their misconceptions from school lessons. Very few of the respondents held the misconceptions from their peers and other sources as shown on the figure. The research revealed that majority of the misconceptions students have about the concept come from both the books and school lessons. This could be linked to the inability of teachers to identify students' misconception about a particular lesson so as to subsequently prepare the lesson to link with what they already know since no student come to class as a blank slate. Knowing the source of students' misconception is a key to making them understand what is taught.

The misconception about the concept emanating from the books could be as a result of the authors' inability to use familiar curriculum research materials thus the need for evaluating curriculum materials before using them. It is even more worrying to find out that some of the books sold on the Ghanaian market are alien to the curriculum and in some cases the writers of such books are not trained teachers at all.

The misconception about the concept emanating from the lessons taught by respondents' teachers could be partly attributed to the fact that most of the science teachers currently in our Ghanaian Senior High Schools are not professional teachers. Keta Senior High Technical School, one of the best science schools in the country has fifteen teachers in the Science Department out of which only two are professionals. Science teachers in the school probably lack the needed pedagogical skills to effectively and efficiently use the best of the teaching approaches whilst teaching the concept ‘solutions and their constituents’.

The lowest percentage (0.77%) of the respondents opined that they learnt about the concept from their friends. This could be due to the fact that most of them believed whatever they learnt from their teachers and so did not need any form of explanation form their friends.

### 4.2.2 Analyses from Classroom Observation

The study observed that the students held some of the misconceptions revealed in the study from their textbooks and the classroom lessons. This was because students kept answering questions not as satisfactory as expected and when questioned by the teacher they asserted that they learnt them from books or from their previous school. A closer examination of the book which cannot be named at least for the purpose of this research revealed a poor presentation of the concept.

## 4.3 Research Question Three (3)

What teaching approach (es) do teachers use whilst teaching the concept under study?

In the quest to provide answer(s) to the research question posed above, the questionnaire as found in Appendix A, the interview; excerpt of which is found in Appendix B and the Observation Schedule found in Appendix C were used.

### 4.3.1 Analyses of Questionnaire Data

Table 6 below shows the summary of the compiled data of responses collected on item 13 of the questionnaire which sought to find out what teaching and learning material(s) the teacher brought to class when he/she taught the lesson on "constituents of a solution".

| Response | Frequency | Percentage |
|---|---|---|
| Pictures | 4 | 3.08 |
| Audio-visual aids | 5 | 3.85 |
| Drawings on cards | 4 | 3.08 |
| None of these | 98 | 75.38 |
| Other aids | 19 | 14.62 |
| **Total** | **130** | **100.00** |

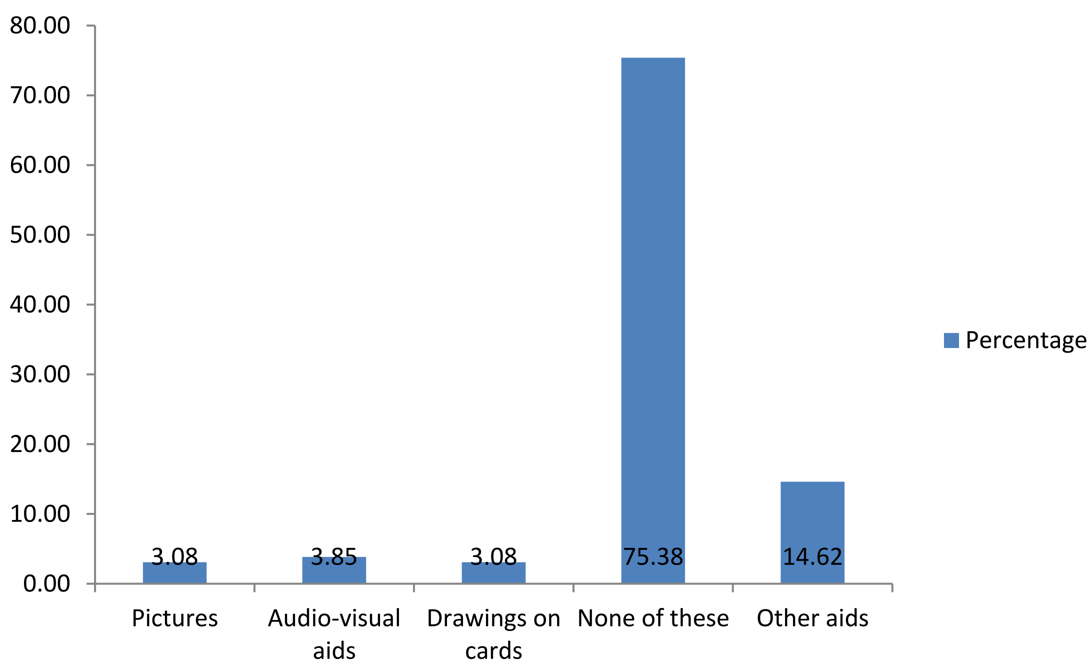


Figure 6: Graph showing respondent's responses on the teaching and learning material their teacher brought to class when he/she taught the lesson on 'constituents of a solution'

It was revealed from the study that majority (75.38%) of the respondents stated that their teachers did not bring any of the teaching and learning aids to class. Only a hand full (14.62%) of respondents stated that their teachers brought other aids which comprised of text books only. This revelation however is not surprising considering the fact that majority of the teachers in the science department were not professional and did not know the importance of using teaching and learning materials in lesson delivery. Even, if they knew, they disregarded the negative effect the absence of the teaching and learning materials would have on the students.

It was also realized during the classroom observation that the teacher did not bring any teaching and learning material to the classroom except his textbook.

The purpose of learning and teaching resources is to provide a source of learning experiences for students. They should be able to facilitate interaction among students and teachers during the learning and teaching process, as well as to help students to learn, broaden students' learning experiences and meet different learning needs. If used effectively, learning and teaching resources can help students to construct knowledge for themselves and develop effective learning strategies, generic skills, values and attitudes, thus laying a solid foundation for life-long learning (Dent and Harden, 2001). This could probably be the reason for the high level of misconception revealed in this study.

To further find out what teaching approach(es) were used in teaching the concept, the responses of the test item 15 of the questionnaire was used.

Table 7: Respondents' responses distribution of what teaching approaches their teachers used.

| Response | Frequency | Percentage (%) |
|---|---|---|
| Demonstration teaching | 31 | 23.85 |
| Lecture | 84 | 64.62 |
| Group discussion | 8 | 6.15 |
| Others | 5 | 3.85 |
| Both Demonstration and group discussion | 2 | 1.54 |
| **Total** | **130** | **100.00** |

The graph below represents pictorially the data as shown in the table

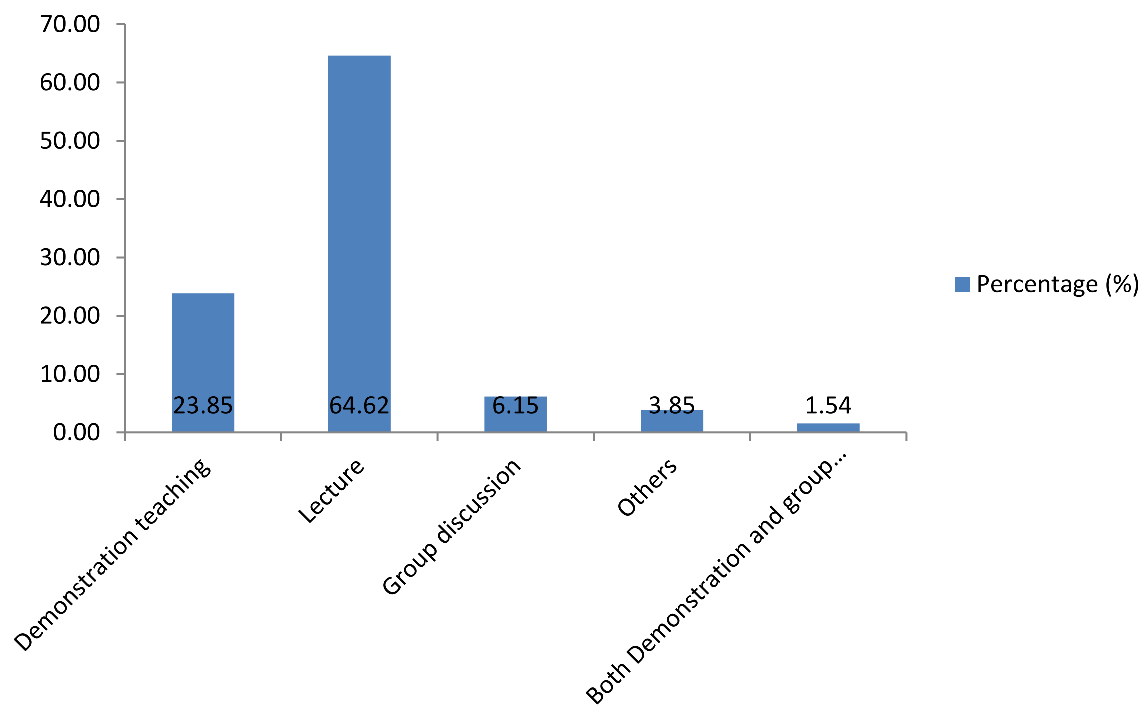


**Figure 7: Graph showing the distribution of respondents' responses on item 15**

The majority of respondents (84 out of 130 respondents representing 64.62% of the entire population used, reported through their responses to item 15 of the questionnaire that their teachers used the lecture method whilst teaching them the lesson on the concept 'solutions and their constituents'. The lecture method, despite the fact that it is the best method to use for large classroom lessons has been proven to have many disadvantages such as the fact that the method places students in a passive rather than an active role, which hinders learning. It also encourages one-way communication; therefore, the lecturer must make a conscious effort to become aware of student problems and student understanding of content without verbal feedback. Worst of all, it requires a considerable amount of unguided student time outside of the classroom to enable understanding and long-term retention of content. In contrast, interactive methods (discussion, problem-solving sessions) allow the instructor to influence students positively when they are actively working with the material.

A little over 20 % of the respondents (23.85%) reported that their teachers used the demonstration method despite the numerous challenges the method poses to both teachers and students. These challenges include the fact that there is the possibility of students being dishonest when teacher has to play the main role in the discussion and demonstration of the topic. Teachers may be tempted to lecture rather than to teach. Teachers do not try more experiments than those given in the prescribed text book. Oral discussion may not be encouraged, since it will go to restrict the demonstration experiment. Also, practical as required may not go hand in hand with demonstration work.

A little over six percent of the population opined that their teachers resorted to group discussion whilst teaching the concept 'solutions and their constituents'

Despite the fact that group discussions could delay the achievement of the target set out by the teacher in his lesson plan, it comes with several benefits such as making learning permanent since learners have been found to learn quickly from their peers.

**4.3.2 Analyses from Classroom Observation**

Observations made from the lesson on the concept under study revealed that majority of the students did not actively participate in the lesson. The students remained passive and were only observed writing notes.

Another predominant feature observed during the lesson was that the entire lesson was teacher-dominated. The students were seldom provided with the opportunity to physically interact with instructional materials and also were not given the opportunity to engage themselves in varied kinds of activities.

The passive nature of the students during the lesson could be because the teacher did not involve the students in the lesson but only lectured. It could also be because the students did not understand the concept taught probably because they held misconceptions that hindered their understanding of the lesson.

The extent of the misconception held may be attributed to the type of school previously attended by the respondents where they were taught the concept.

Table 8: Type of school and frequency distribution of the respondents

| Type of J.H.S attended | Frequency | Percentage (%) |
|---|---|---|
| Public | 38 | 29.23 |
| Private | 82 | 63.08 |
| Mission | 10 | 7.69 |
| **Total** | **130** | **100.00** |

The majority of students (82 out of 130) representing 63.08% of the population reported that they attended private schools, whilst 38 out of the 130 students attended public schools. Very few (10 out of 130 students) attended mission schools according to the compiled data. The type of school the respondents attended which were mainly private schools could be suffering from some poor supervision by the heads as reported by Osakwe (2013) or probably be due to the fact that majority of the private schools recruit non- professionals who are most often deficient in the pedagogical skills hence might not have used any teaching and learning material(s) as confirmed by the respondents from the questionnaire data.

From the study, it has been established that the majority of teachers who taught the lesson on the concept 'solutions and their constituents' were in the private schools since majority of the respondents attended private schools.

Students from private schools might not have been exposed to the concept and even if they have been taught, teachers might have used teaching methods not friendly to students. Poor teaching methods could lead to low cognitive achievements in students but rather have the potential of exposing students to misconceptions.

It was also revealed that majority of the respondents (70% of the respondents) were males whilst 30 % of them were females.

Below is a table showing the distribution of males and females respondents involved in the study.

Table 9: Gender distribution of respondents in the study.

| **Gender** | **Frequency** | **Percentage (%)** |
|---|---|---|
| Male | 91 | 70.00 |
| Female | 39 | 30.00 |
| **Total** | **130** | **100.00** |

Table 10 below shows the age and frequency distribution of the respondents.

| **Age (years)** | **Frequency** | **Percentage (%)** |
|---|---|---|
| less than 14 | 2 | 1.54 |
| 14-16 | 64 | 49.23 |
| 17-19 | 58 | 44.62 |
| 20 and above | 6 | 4.62 |
| **Total** | **130** | **100.00** |

# CHAPTER FIVE

## SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

### 5.0 Overview

This chapter of the study discusses the summary of findings, conclusions and educational implications of the study for science teaching and for further studies. It continues with the recommendations of the research study.

### 5.1 Summary of findings

The main factors that were identified as the contributors to the misconceptions held by students included the teaching approaches teachers used whilst teaching the lesson on the concept “solutions and their constituents”, the kind of text books and other reading materials flooding the educational system. It was also revealed that science students of the Keta Senior High Technical School to a significant extent held misconceptions about the concept “solutions and their constituents”.

### 5.2 Conclusions

It must be noted that the whole teaching and learning setting in a school can be said to be a knowledge industry and so leaving students to their misconceptions and hoping that they will overcome them is unfair.

Keta Senior High Technical School which is currently the best Science school in the Volta Region of Ghana as adjudged by the W.A.E.C in 2015 could become a hub of excellence in science education if misconceptions of concepts such as the one under study are effectively and efficiently addressed without delay.

A good teaching approach could help in addressing the challenge first year science students of the school face with respect to the concept ‘solutions and their constituents. A good science teacher is a facilitator to learning concepts such as the one under study and also to assist students to reject their preconceptions. The good teacher does this by trying to provide students with exactly the defects regarding the beliefs they hold and to consistently provide the students with meaningful examples and other problems that are associated with the acquisition of knowledge on a concept.

Rigid teaching methods such as lecturing and reading from textbooks were very much pronounced in the lesson observed.

Teachers do not take into consideration the integration of different media such as charts, pictures and real objects when teaching, especially new concepts.

**5.3 Recommendations**

In view of the findings and conclusions drawn from the study, the following recommendations are posited:

First year science students of Keta Senior High Technical School should be helped to undergo appropriate conceptual change and form simple science concepts by following the under listed principles:

The students must be guided by the science teachers by providing them with excellent explanations of concepts. They must also be provided with solid evidence that will enable students to reject their misconceptions. This can be done by asking students to provide their views on concepts, justifying their explanation as well.

Students should be guided to link the new concepts to their real life situation by providing the students with meaningful examples.

Science teachers should begin to employ different media such as pictures, drawings, charts and real objects in their lesson delivery and ensure the media used at every stage lead to the desired objective of the lesson

Science students should be given the opportunity to express their views on concepts whilst the teacher corrects any misconceptions.

Science teachers should employ more practical lessons than lecture since students learn effectively and efficiently when they are involved in the practical lesson. This means that the Science Resource Centre should be adequately stocked with the needed apparatus, equipment and chemicals.

The Curriculum Research Development Division of the Ghana Education Service should take the necessary steps to get rid off all sub-standard science textbooks and materials on the market since students buy these books without expert advice from qualified science teachers.

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# APPENDICES

## APPENDIX A

## SAMPLE QUESTIONNAIRE USED FOR DATA COLLECTION

Dear student,

The questionnaire before you is purely for an academic exercise. I shall appreciate it very much if you could spend some few minutes to respond to the items in this questionnaire. Please be assured that your responses shall be treated with utmost confidentiality. Please tick the correct response using √. Thank you in advance.

SECTION A (BIODATA)

1. Gender: M [ ] F [ ]

2. Age: < 14 years [ ] 14 – 16 years [ ] 17 -19 years [ ] 20 years and above [ ]

3. Type of Junior High School attended: Public [ ] Private [ ] Mission [ ]

**SECTION B**

| ITEM No. | STATEMENT | Strongly agree | Agree | Not sure | Disagree | Strongly disagree |
|---|---|---|---|---|---|---|
| 4 | I have ever read, been taught or told about solutions in science | | | | | |
| 5 | I understood what I studied | | | | | |
| 6 | A solution is only formed when a solid substance dissolves in a liquid | | | | | |
| 7 | The concept 'solutions and their constituents' is very confusing | | | | | |

8. All the following are examples of solutions except

(a) Salt in water (b) alcohol in water (c) sugar in water (d) None of the above

9. Which of the following can be considered as a solution?

(a) Gari in water (b) powdered chalk in water (c) steel (d) None of the above

10. I learnt about the concept 'solutions and their constituents' from

(a) books (b) school lessons (c) peers/friends (d) others

*Please skip item 11 if your choice for item 10 is not* ***'others'***

11 If others, please specify where you learnt the concept from

………………………………………………………………………………………

12 How did your teacher handle students' confusion during the lesson on 'constituents of a solution'?

……………………………………………………………………………………….

13 What teaching and learning material did your teacher bring to class when he/she taught the lesson on "constituents of a solution"?

(a) Pictures (b) audio-visual aids (c) drawings on cards (d) None of these (e) Other aids

14 If other aids, please specify which aids your teacher used

…………………………………………………………………………

15 Which of the following teaching approaches did your teacher use whilst teaching the lesson on 'constituents of a solution'?

(a) Demonstration teaching (b) lecture (c) group discussion (d) Others

16 Please specify what teaching approach was used if your choice in item 15 is others

………………………………………………………………………………………

# APPENDIX B

## EXCERPT OF INTERVIEW

Researcher: What do you know about solutions?

Interviewee: Solutions are uniform mixture of a solid and a liquid.

Researcher: What do you imply when you say mixture of a solid and a liquid?

Interviewee: The solid is usually the hard substance and the liquid is water.

Researcher: Please mention one example of any solution you know.

Interviewee: Sir, "Gari soakings"

Researcher: Why do you say gari soakings is a solution?

Interviewee: Because the gari is mixed with the rest of the other ingredients.

Researcher: Please tell me where you learnt the concept of solutions and their constituents from.

Interviewee: I learnt the concept from my J.H.S Science teacher.

Researcher: During the lesson, were you shown some pictures or drawings of any type of solution.

Researcher: Are you aware of solutions that are solids?

Interviewee: No, how is this possible? It is not possible!

# APPENDIX C

## CLASSROOM OBSERVATION SCHEDULE

| | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|
| Effective and relevant introduction linked with R.P.K | | | | | | |
| Systematic and sequential presentation adapted to the level of students | | | | | | |
| Proper and effective use of language | | | | | | |
| Effective use of teaching and learning resources | | | | | | |
| Clearly explained task setting | | | | | | |
| Students' listening skills | | | | | | |
| Students' ability to ask relevant questions | | | | | | |
| Students ability to provide correct explanation to questions during lesson | | | | | | |
| Students level of concentration during lesson | | | | | | |
| Students involvement and participation | | | | | | |
| Opportunity available for students to interact with instructional materials | | | | | | |

Key (5-Excellent, 4-Very good, 3- Good, 2- fairly good, 1- poor, 0- absent)