P-ISSN: 2790-6795	Annals of Human and Social Sciences	April-June 2023, Vol. 4, No. 2
O-ISSN:2790-6809	http://doi.org/10.35484/ahss.2023(4-II)25	[265-272]

Annals of Human and Social Sciences
www.ahss.org.pk

RESEARCH PAPER

An Exploration of Students' Common Misconceptions in the Subject of Chemistry at Secondary Level

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ABSTRACT

Ideas, things, or actions that support us comprehend the worlds around us are referred to as concepts. Students' misunderstandings are frequently deep-rooted, instruction-resistant barriers to scientific concept acquisition that persist even after instruction. Misconceptions are components of a larger knowledge system that contains a number of interrelated ideas that students use to make sense of their lives, and they are particularly frequent in courses that are abstract in nature. The current study explored misconceptions of three basic concepts which are present in the textbook of grade 9th and literature also supported that most of the misconceptions are found in these topics. Atomic structure, compound structure, and chemical bonding are examples of these ideas. The sample included 15 chemistry students. A semi-structured interviews were conducted to collect data. The interview transcripts were transcribed. Different misconceptions were explored about these topics. Teachers should include strategies for resolving misconceptions in their curriculum into their teacher's curriculum, and according to the study's results, instructors should be given the tools they need to recognize their students' misconceptions and adopt remedial teaching techniques.

Keywords: Chemical Bonding. Misconceptions, Structure of Atom, Structure of Compound

Introduction

Concepts are regarded of as thoughts, things, or occurrences that assist us in comprehending the world around us (Eggen & Kauchak, 2004). Students' misconceptions are frequently deep-rooted, instruction-resistant barriers to scientific idea acquisition that persist even after teaching. Students utilise a larger knowledge system that contains a range of related ideas to make sense of their life, which includes misconceptions. Students have preconceived notions that they formed before and during their early school years. Misconceptions may result through students' interactions with instructors and the physical and social world, as well as from textbooks.

Misconceptions arise, however, not only from students' contacts with the physical and social world and from textbooks, but also as a result of interaction with teachers (Valandines, 2000). Misconceptions among students can have a significant influence on their learning. Students enter the classroom with pre-requisite information, which is gradually expanded upon as they go through their education. Most of the misconceptions are found in the subject of Chemistry due to its abstract nature. There are several studies in the literature on understanding students' conceptions in science (Duit, 2014; Reiner; Wandersee, Mintzes& Novak, 1994). Mulford and Robinson (2002), state that when it comes to studying chemistry, pupils are not blank slates. They have prior knowledge, perspectives, and background information about chemistry, all of which can influence how well they grasp chemical topics. Formation of misconceptions will adversely affect students' subsequent learning (Garnett, Garnett &Treagust, 1990).

Misconception is any idea or concept that varies from scientifically accepted perception of that concepts is known as misconception or an alternative conception (Shaheen, 2010). Misconceptions are defined as students' erroneous or nonscientific beliefs or knowledge about a given topic, which are mostly produced by their lack of comprehension of the subject (Morgil, Seyhan, &Secken, 2009). Everyone used to create information that suited their experiences, but misconceptions are resistant to instructions. Recent research on students' conceptual misunderstanding of the natural phenomena indicates that one cannot learn new concepts if alternative models that explain a phenomenon already exist in ones minds. Students' misconceptions are frequently profoundly held, largely unexplained, and vehemently defended. According to Selvi and Yakisan, (2004), misconceptions can be caused by a variety of factors, including partial knowledge, inadequate cognitive development of the learners' language, and inappropriate teaching techniques. According to prior study, impoverished students not only have chemistry misconceptions, but they also frequently misinterpret what they are taught in class in a variety of other areas (Taber, 2000).Vosniadou (2001), stated that if students have misconceptions, then there will be disequilibrium and they will try to create equilibrium, and this misconception leads toward concept formation. Students must be given time and opportunity to discover why their concepts are different from scientific concepts and they themselves change their alternative conceptions. Misconception leads toward conception and conception leads toward misconception.

Misconception in the Subject of Chemistry

One of the most significant disciplines of science is chemistry and world filled with interesting wonders, attractive experimental activities and fruitful knowledge for understanding the natural and manufactured world (Chiu, 2005). However, it is complex for its abstract nature and its relatedness with mathematics. Barke (2009) stated that chemistry is difficult as it demands more concentration to be given to a great diversity of activities and skills in comparison with others areas of science. Due to the abstract character of many chemical concepts and the challenging nature of the chemistry language, chemistry is a challenging subject (Aguirre, Haggerty & Linder, 1990). Students have difficulty in these areas for two reasons: first, the themes are highly abstract (Ben-Zvi, Eylon, & Silberstein, 1988), and second, ordinary language terms are utilized but with distinct meanings (Bergquist & Heikkinen, 1990). Misconceptions among students in school sciences at all levels are a major source of worry for scientific instructors, researchers, and learners (Johnstone & Kellett, 1980). Misconceptions are built in many areas of chemistry in the literature like atomic structure (Cetingul et al., 2005; Nakiboglu, 2003; Park & Light,2009) electrochemistry (Ahtee et al., 2002; Barke et al., 2009; Dhindsa & Treagust, 2009) oxidation and reduction (Lin & Chiu, 2007) chemical equilibrium (Cheung et al., 2009; Coll & Treagust, 2001) chemical bonding (Bilgin, 2006; Dindar et al., 2010; Unal et al., 2010) and concepts of acids and bases (Kousathana et al., 2005; Lin & Chiu, 2007; Ozkaya et al., 2003). Researchers were able to gain a better grasp of learners' cognitive processes linked to their conceptualizations by being aware of misconceptions associated with these ideas. It also makes it easier to improve teaching methods, students' chemistry modeling experience, and textbook representations of chemical topics.

Atomic structure and chemical bonding is one of the key and basic fundamental concepts of Chemistry (Taber, 2003). Al-Balushi (2009) found that students have misconception regarding the structure of an atom. He found that students do not have clear idea about the shape of the orbits, number of particles in an atom. He also found that students have the conception that the atomic orbits are circular in shape in which electrons revolve around the nucleus. Harrison and Treagust (1996) investigated students' misconceptions regarding the structure of the atom in grades 8-10.

Students cannot see an atom, it is difficult for them to understand the concepts involves in the topic of chemical structure and bonding and there is great potential for formation of students misconception (Taber, 2003According to Ozmen's (2008) research, covalent connections are destroyed when a substance's form changes. In the literature, the myth of equal electron sharing in covalent interactions has been thoroughly investigated (Dhindsa & Treagust, 2014; Ozmen, 2008 & Al-Balushi, 2009). Peterson and colleagues (1986) looked at a few common misconceptions concerning covalent bonding and structure. They also discovered a high tendency to confuse intermolecular forces with the molecule's covalent link, as well as a lack of understanding of the magnitude difference between the strength of a covalent bond and the strength of an intermolecular force. A similar misconception discovered by Treagust (1986) is that when a material changes state, covalent connections are disrupted.

Researchers can learn more about how learners' cognitive processes are linked to their conceptualizations by being aware of misconceptions linked with these ideas. It also makes it easier to improve teaching methods, students' chemistry modeling experience, and textbook representations of chemical topics. Teachers who are more knowledgeable about the sorts of erroneous ideas that children are likely to possess will be faster and better at detecting them, assisting children in recalling and making explicit their false beliefs, and incorporating them into the conceptual transformation process. Thus, if teachers know about the pre-knowledge of their students, then it is critical in the kids' learning. The study attempts to explore the common misconceptions of students' in the subject of Chemistry in the fundamental concepts of Chemistry.

Material and Methods

Design is a plan for generating empirical evidence that will be used to answer the research questions. This study was aimed to explore the basic misconceptions of students in the subject of Chemistry. Qualitative research design was used to conduct the study. Qualitative data was collected and analyzed to understand the phenomena. Qualitative data gave possible themes and or deeper themes that might be challenging to capture with quantitative data.

Sampling

Purposive sampling technique was employed to collect the data. The sample size consisted of 15 students of grade 9th from different schools. Chemistry is introduced as a subject from the grade 9th and it includes the basic concepts of chemistry, so the students of grade 9th were selected as the part of the sample.

Instrumentation

Interview protocol was developed based on research questions, by reviewing the relevant literature, researcher's observation and prior experiences. After analyzing the current literature, the interview questions were created on the misconceptions of atomic structure, the structure of compound and chemical bonding. Research instrument was validated by two experts. One expert was from the area of Education while one was from the area of Chemistry. Moreover two mock interviews of grade 9th were conducted to further test the validity of the instrument. Some changes were made in the interview questions as proposed by the experts and keeping in view the two interviews conducted as pilot testing of the instrument. One question was deleted due to overlapping of the concept and statement of one question was modified for the better understanding of the respondents.

Results and Discussion

Table 1
Students Response regarding Misconception

Major Misconceptions	Students Response
Shape of the orbits is round.	Orbits are round. Orbits are circular. I never understand the shape of an orbit. Orbits seems like a ball in the space.
Atom is composed of only three components.	Atom consist of electrons, protons and neutrons. There are only three particles in an atom. There are three components of an atom. Atom is the smallest unit having three particles.
Shape of molecule change as the state of molecule changes.	When ice is converted into water the shape of the molecule also changes. When we convert water into ice the shape of the molecule also changed because the change in its state The change of ice into water also causes change in shape of molecule. When we boil the water it changes its state, it is due the change in shape of molecule.
When water molecule disassociates, it is converted into hydrogen and oxygen atoms.	When any molecule disassociates, it is converted into the parent atoms which it is composed. Disassociation of any molecule causes its break into its components. When water molecule disassociate it is converted into hydrogen and oxygen. Disassociation of any molecule breaks the molecule into its smaller components.
Shape of molecule depends on the type of chemical bonding.	Shape of water molecule depends upon the bonding between oxygen and hydrogen atoms. The shape of sodium chloride depends upon the type of bond among sodium and chloride. The shape of carbon dioxide depends upon the bond between carbon and oxygen. Shape of any molecule is based on the type of bond between the atoms of the molecule.
When a stick or anything is broken, bonds are too tiny to be impacted.	Bond between hydrogen and oxygen is very small and it can be breaking by applying some force. Bonds are the physical entities and they can be break when we apply a force.
Electrons from the atoms involved in the bond are attracted in the same way since all covalent bonds have the same number of electrons.	Covalent bonds are formed by the sharing of electrons. Single, double and triple covalent bonds share the same number of electrons, they only differ in strength of attraction between two atoms.
Shape of water molecule is bent due to strong chemical bonding.	Water molecule is bent due to strong chemical bonding. The shape of water molecule is bent due to strong covalent bond

Table 2
Percentages of Major Misconceptions

Major Misconceptions	Percentage
Shape of the orbits is round.	60%
Atom is composed of only three components.	46.67%
Shape of molecule change as the state of molecule changes.	66.67%
When water molecule disassociates, it is converted into hydrogen and oxygen atoms.	73.33%
Shape of molecule depends on the type of chemical bonding.	33.33%
Bonds are too little to be impacted when a stick or anything is broken. 40%students respond that bonds are the physical links between two atoms.	53.3%

Electrons from the atoms involved in the bond are attracted in the same way since all covalent bonds have the same number of electrons.	33%
Shape of water molecule is bent due to strong chemical bonding.	73.33%

Conclusion

Present study explored that shape of the orbit is round or circular and there are three components or particles in an atom. The findings are consistent with the findings of Al-Balushi (2009). He found that students' do not have clear idea about the shape of the orbits, number of particles in an atom. Harrison and Treagust (1996) looked at the misconceptions of pupils in grades 8-10 concerning atomic structure. He explored that students' do not know about the shape of the orbits.

The present study revealed three major misconceptions of structure of compounds. It is explored that shape of a compound/molecule changes as the state of compound changed. It is also explored that change in state causes change in structure of compound. It is also found that shape of compound depend upon type of chemical bond. The findings of the current study are related to the other studies. Previous studies found that water molecule turns into hydrogen and oxygen atoms by changing the state (Barke et al., 2009).

It is also explored that hydrogen bonding is a type of chemical bonding. It is also explored that students have misconception about the concept of co-ordinate covalent bond. The equal sharing of electrons is used to produce co-ordinate covalent bonds, which is investigated. Furthermore it is also explored that shapes of compounds depend upon the type of chemical bonding. The findings of the current study are related to the other studies. Covalent bonds are also disrupted when the form of a material changes, according to Ozmen's (2008) research. Bonds are physical (material) connections between atoms, according to some participants in the current study. Pabuccu and Geban both mention this belief in the realised character of chemical bonding (2006). In the literature (Dhindsa & Treagust, 2014), this particular misconception (Pabuccu & Geban, 2006) of fair electron sharing in covalent interactions was widely documented (Ozmen, 2008) implying that chemistry textbooks and professors have done a poor job of addressing this issue (Al-Balushi, 2011).

Recommendations

Teacher education programs should aware the chemistry teachers about different misconceptions of chemistry so that they may help the students in developing the right concepts. Teacher education programs should provide instructors with the skills they need to recognize their students' misconceptions and use remedial instructional techniques on a regular basis.

Pre-service and in-service teacher education programs should highlight the significance of identifying and correcting student misconceptions, as well as chances for pre-service and in-service instructors to practice these strategies under supervision. Teachers in training should attend seminars and workshops to learn about common misconceptions, their causes, and how to address them. Although subject matter knowledge is an essential predictor of student knowledge, it is not the only factor to consider, teachers must be aware of any misunderstandings that students may have in order to maximize the impact of their instruction.

In the present study only three basic concepts of chemistry were selected to explore the misconceptions in the subject of Chemistry. For future research more concepts can be selected to explore the misconceptions. This research can be replicated on large sample size. This research can be replicated by using different instruments to explore different misconceptions.

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