Exploring Teachers' Understanding about Misconceptions of Secondary Grade Chemistry Students

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Abstract

Misconceptions are the obstacles in students' learning. Teachers play a major role in the learning of the students. Therefore, teachers should be aware of the nature of misconceptions and possible remedies to mediate the misconceptions. The present qualitative study was designed to investigate the chemistry teachers' understanding regarding students' misconceptions. The findings of the study will contribute towards the learning community and add up to the existing body of literature. It would be beneficial for the curriculum developers of teacher educators. It will also be advantageous to teacher trainers. The sample included 15 chemistry teachers who were selected purposively. Semi-structured interview was used as a tool for data gathering. The interview transcripts were transcribed after thematic description. The results revealed that most of the teachers understand the terminology of misconceptions. However, they do not possess the knowledge about the sources of these misconceptions and techniques to rectify them. In addition, the teachers do not consider the possible misconceptions that could generate from their teaching. On the basis of the findings, it is recommended to incorporate the techniques required for the mediation of misconceptions in the curriculum for teacher educators. It is necessary to equip teachers with essential capabilities of continuously identifying their students' misconceptions and implementing remedial instructional strategies.

1. Introduction

Misconceptions are the ideas held by students which are not scientifically accepted. In the words of Morgil, Seyhan and Secken, misconceptions are false or nonscientific thoughts or knowledge of the students about a specific problem and are caused mainly by their misunderstanding of the subject [1]. Misconceptions are hurdles in the meaningful learning of the students. Misconceptions are those conclusions which are not acceptable, but they appear quite acceptable to those who have successfully manipulated the false concepts to fit into existing framework. The factors causing the misconceptions are personal experience, school teaching, social environment, culture, textbooks and teachers [2] [3].

The new knowledge should be related with the students' prior knowledge for the meaningful learning. The teaching plays a main role in the meaningful learning of the students. So, the teachers should be aware of the misconceptions that students might hold. Teacher should consider the previous knowledge while teaching, as it is the main characteristic of constructivist teaching. The teacher will tailor the teaching strategies which would be helpful in reorganizing students' knowledge frameworks for new learning. Thus, having the awareness about the pre-knowledge of their students will be beneficial in the meaningful learning of the students. It is important to explore the teachers' awareness about students' misconceptions to inform educators.

Past researcher has focused on the awareness of misconceptions by the elementary science teachers [12]. The research has to be done on the content specialist teacher who teaches probably the same content multiple times in one day. According to Chiu, chemistry is considered as difficult subject among other science subjects and students experience many misconceptions in this subject [13]. So, due to this reason chemistry is selected for this research.

Atom is the fundamental concept of chemistry and if students have misconceptions about fundamental chemistry concepts then they will certainly have misconceptions in complex chemistry topics. As mentioned earlier that teachers' awareness regarding misconceptions in chemistry play an optimal role in the learning of students.

In view of the above discussion this study is aimed at exploring teachers' understanding about misconceptions of secondary grade chemistry students on the basis of following research questions:

1. What do the teachers understand relating to the concept of prior knowledge of students and misconceptions?
2. What are the teachers' believes about the sources of misconceptions among the students?
3. What is the teacher awareness about the common misconceptions relating to the topic of atom existing in the research literature?
4. What are the teaching techniques they use to encounter the misconceptions?
5. What are the sources they use for preparations in advance of the class?

2. Theoretical Framework

The theory of constructivism served as a basis for this research work. According to constructivism, learner constructs their knowledge through hands-on minds-on practice. Constructivist believes that knowledge is not transferred but created by the learners during the learning process [19]. So, the misconceptions or alternative conceptions that a learner might have about a concept may cause hurdle in the further learning.

Along with constructivism, theory of personal constructs also served for the purpose of this research. According to this theory, individual constructs and predict the future events based upon their prior knowledge. Previous knowledge is the essential feature of human's thinking procedure. New experiences are mounted upon the previous knowledge.

According to both theories, it is evident that the leaning is centered on the learners. Their previous knowledge plays a very important role in the meaningful learning of the students. The misconceptions can hinder the learning of the students. The misconceptions should be rectified to cause the meaningful leaning of the students. It is necessary for the teachers to have awareness about misconceptions of the students. The teachers should have the knowledge about the misconceptions

3. Literature Review

Misconceptions are resistant to instructions because everyone used to construct knowledge that fits into their experiences. Schmidt noted that once misconceptions about the topic are formed, it will subsequently interact with further learning of the students [4]. Novel concepts cannot be learned by the students, if they already have misconceptions about the fundamental concepts [4]. Misconceptions are often deeply held, largely unexplained and strongly defended by students.

The alternative conceptions or misconceptions are the obstacles in meaningful learning. Literature review reveals that not only weak students have misconceptions, but there are a wide range of areas where pupils commonly misunderstand the chemistry they are taught in class. Students come to schools having some pre-concepts in their minds which later on develop into misconceptions.

Student's misconceptions have their origins in a diverse set of personal experiences. Students' alternative ideas are sometimes so ingenious that they cannot be easily invented and their invention requires much more effort than simply learning the conventional ideas that are taught in the class [5]. The misconceptions are permanent and cannot be changed or corrected easily [1] [4]. Simply telling the students that their concept is incorrect is not sufficient. It is evident through the research, that individual's misinterpretation concerning any concept will hinder the further learning.

The students hold some previous experience while entering the school. The students try to make connections between the new and old concepts. If they have misconceptions, then it will hinder their subsequent learning. Misconceptions are stuck strictly to the mental structures of the students. Merely informing the students about the new concepts do not mediate the misconceptions [1]. Misconceptions in the fundamental concepts (e.g. atoms and molecules) will hinder the advance learning in chemistry [6]. The misconceptions about fundamental chemistry concepts will lead towards the further misconceptions in advance chemistry topics. Students are not blank slates when they came to study chemistry [7]. They have previous understanding, perceptions and background knowledge about chemistry which may affect understanding of chemistry concepts.

The research has shown that the teachers are also a cause of misconceptions among the students. The teaching can also cause misconceptions among the students [20]. The teachers play a major role in the meaningful learning of the students [2], [8]. While, students can hold the same misconceptions that their teachers haves [2], [9], [10], [11]. While lesson planning, teachers must consider the possible misconceptions that could arise during the instruction [9], [20].

Misconceptions are the cause of hurdle in the meaningful learning of the students. There are numerous sources of misconceptions explored by the numerous researchers. The sources of misconceptions are textbooks, daily experiences, teachers, peers, society, and instructional strategies. The teachers should have awareness of the sources of misconceptions [20].

It is evident through numerous researches that there are specific instructional approaches which are helpful while encountering student misconceptions [5], [9]. These instructional strategies are proved to be effective in overcoming the misconceptions among the Chemistry students [17], [10]. However, these techniques include some sort of hands-on minds-on experience which would help in tackling the misconceptions by the students. The teacher plays a key role in this whole process by engaging students in the learning process by different constructive strategies [18]. So, the teachers should be familiar with the possible misconceptions that the students might hold and they should consider it while planning for their lesson plans [18].

It is, explored through various researches that teachers are the major source of misconceptions among students [2], [8]. Therefore, teachers' awareness regarding the misconceptions should be explored.

4. Methodology

A qualitative research design is used in this study. This study aims at investigating the teachers' understanding regarding misconceptions in the students, so the qualitative research design is the most appropriate for the study.

4.1. Sample for the study

The purposive sampling technique was utilized for the study. The sample consists of the chemistry teachers. The sample size was 15. These participants were the secondary school chemistry teachers. The sample is drawn for the public sector schools. The informed consent was signed by the participant in order to maintain participant anonymity.

4.2. Instrumentation

The researcher had selected the interview as a tool for data collection. A semi-structured interview was developed for the purpose of data collection.
The researcher herself collects the data. Most of the interviews were audio taped with the consent of the interviewees. The interview questions were formed through reviewing the existing literature on the misconceptions. The instrument was validated through the expert's opinion. The instrument was pilot tested on the pre-service teachers to analyze the understanding of the interview questions by the participants. It was improved after pilot testing.

4.3. Data Analysis

The semi-structured interviews were coded nitially into the two main categories which were "understanding about misconceptions" and "teaching strategy and misconceptions". These main themes were then divided into sub-themes. The sub-themes relating to the theme "understanding about misconceptions" are: definitions of misconceptions by the teachers, sources of misconceptions and examples of the students' misconceptions are. Whereas, the subthemes relating to the theme "teaching strategy and misconceptions" are: planning the instruction and instructional techniques to address student misconceptions.

5. Results

This section presents the results revealed through the analysis of data. This study was designed to investigate the chemistry teachers' understanding about the misconceptions. The data were collected from teachers who have experience in teaching of chemistry. Semi- structured interview was conducted by the researcher. After the data collection, data was analysed using the thematic analysis technique by the researcher. Different opinions of teachers were obtained to investigate the awareness of teachers about the misconceptions among students. The responses of the teachers and their interpretations in respect to the different themes are presented in the following section.

5.1. Theme: Understanding about misconceptions

5.1.1. Definitions of misconceptions by the teachers. Misconceptions are those beliefs which are not accepted scientifically [17]. The 20% of the interviewees were not familiar with notion of "misconceptions" and subsequently they were unable to define misconceptions. Most of the teachers (80%) gave the definition of misconceptions. But, those definitions were not much clear. A teacher said, "When students do not understand a concept then it is misconception".

The teachers interviewed associated the definition of a misconception to the nature of the chemistry subject "Misconceptions are the confusions that students might have due to its abstract nature. They perceive that they had understood the concept, but they have the incorrect understanding of it". They were not aware that the student misconceptions arise from previous knowledge and experience.

5.1.2. Sources of Misconceptions. The sources of misconceptions were explored by interviewing the participants are presented in the Figure 1.

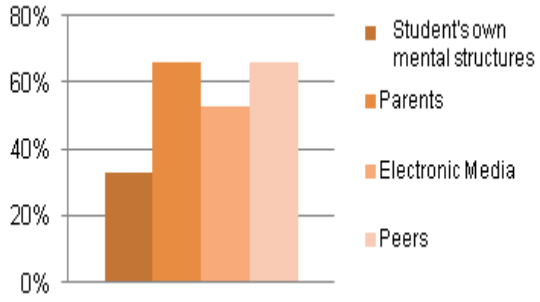

Figure 1. Sources of misconceptions

Most of the teachers believes parents and peers as the source of misconceptions. Moreover, about half of the teachers said that electronic media (e.g. cartoons) is a source of misconceptions. Only one third of the teachers have a belief that students own mental structure can be the source.

5.1.3. Example of the students' misconceptions. One third of the teachers were not able to give any

example of misconceptions relating to the fundamental concept of atom. Some teachers' examples clarified that the teachers are themselves confused about the concept of misconceptions and misunderstanding.

5.2. Theme: Teaching strategy and Misconceptions

5.2.1. Planning the Instructions. The teachers do not consider misconceptions while planning for their instructions beforehand the class. When the teachers were asked the reason for not considering misconceptions, most of the teachers replied that they can "cope up with the situation because of their experience".

5.2.2. Pedagogical Strategies to Tackle with Student Misconceptions. The pedagogical strategies utilized by the teachers to address misconceptions were explored.

Table 1. Instructional techniques to address misconceptions

Instructional techniques	Response percentage
Some form of investigation or experimentation	33%
Inquiry based teaching	60%
Not any method special method is necessary	27 %
Not any instructional technique could mediate a Misconception	20%

Table 1 summarizes the response percentage of the teachers in terms of pedagogical strategies to tackle with student misconceptions. One third of the teachers said that some sort of investigation or experimentation could be utilized to address the misconceptions. They state that hands-on activities can be utilized to mediate the misconceptions. About 60% of the teachers said that inquiry-based teaching can adopted to correct the misconceptions. They state that the questioning answering method is very viable measurement for encountering the misconceptions. About 27 % of the interviewees answered that the scientific explanation could mediate the misconceptions and any special method is not required for this. Moreover, 20% of the teachers replied that instructions could not mediate the misconceptions, rather students are themselves responsible for the learning. One of the teacher responded "the students' internal curiosity or interest in the subject is the only factor that can eliminate the misconceptions".

6. Discussion

The teachers should have the awareness of the possible misconceptions as it would help in tailoring the instruction accordingly [20]. This prior planning will also help the teachers to choose the specific activities to mediate the misconceptions. There are studies that justify the use of scientific technology tools by teachers in order to engage students and assist them in overcoming basic science misconceptions, or in understanding abstract ideas through concrete examples or models [6], [13], [15]. Teachers are unaware of this. Teaching aids may be used with students to overcome science misconceptions [16].

The textbook is the major source utilized by biology teachers in America [14]. In Pakistan too, science teachers, rely solely on textbooks for the appropriate content materials that satisfy the requirements of the science. Textbooks are the only learning materials available and used in most Pakistani schools. So, it is essential for the teachers to know that textbooks are sources of misconceptions. The other sources of misconceptions are peers, students' own mental structure, parents and their social environment [20]. There are studies that justify the use of scientific technology tools by teachers in order to engage students and assist them in overcoming basic science misconceptions, or in understanding abstract ideas through concrete examples or models [6], [13], [15]. Teachers are unaware of this. Teaching aids may be used with students to overcome science misconceptions [16].

7. Conclusion

Most of the teachers are not familiar with the misconceptions, which is an alarming situation. Some teachers misinterpret or misunderstand the concept of misconceptions. According to the teachers, the misconceptions are misunderstanding of the concepts that the students hold.

They state the sources of misconceptions are students' themselves, parents, teachers and peers. They are unaware of textbook as a source of misconception. However, textbook is utilized so frequently in the teaching. The teachers are lacking in the catering of misconceptions while planning the lessons. Teacher should consider the possible misconceptions that could arise from the topics they are preparing to teach.

Teachers should utilize innovative teaching methods with the students to mediate the misconceptions. These methods should be based upon the hand-on minds-on experiences

Based upon the above conclusions it is recommended that:

1. Subject matter knowledge is an important predictor of student knowledge but the teacher must

have the knowledge of misconceptions that the students might hold to maximize the effect of their teaching. Teacher trainers should incorporate the techniques required for the mediation of the misconceptions in the curriculum for teacher educators.
2. Teacher education programs should equip their teachers with the essential capabilities of continuously identifying their students' misconceptions and implementing remedial instructional strategies.
3. Pre-service and in-service teaching programs should emphasize the importance of identifying and mediating misconceptions among the students and provide opportunities for pre-service and in-service teachers to practice these strategies under the supervision.
4. Seminars and workshops should be organized for the in-service teachers to make them aware about the misconceptions, origin of misconceptions and techniques utilized for encountering the misconceptions.

8. References

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