A Study of Misconceptions in Science among Students of Standard VIII of Ranchi District

An

Abstract submitted to

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1.0 Introduction

Science is the cumulative and endless series of empirical observations, which results in the formation of concepts and theories, with both concepts and theories being subject to modification in the light of further empirical observations. Science is both a body of knowledge and the process of acquiring knowledge (Fitzpatric, 1960). According to NCF 2023, students come to school with their own theories about the world around them. These theories develop as they observe the world around them and seek explanations for what they see. Often, these theories conflict with what is being discussed in the classroom. Their existing notions do not get addressed in the classroom, and there is a separation between 'home' and 'school' science. As students move to higher grades, the demands on them increase, and the curricular load becomes greater. The need for abstract thinking also increases. It is critical that the students develop the capacities to be able to make the progression. However, the current focus on facts does not build these capacities. Also, the time for understanding each concept is limited, so alternative conceptions may develop that are difficult to address.

1.1 Misconceptions in Science

Misconceptions are often defined as ideas that persons believe to be true but do not necessarily match scientific evidence (Pine & West, 1986). Carey (2000) defines misconception as the inability of the students to apprehend scientific concepts correctly. According to Mondal and Chakraborty (2013) the word misconception implies (a) students' mistaken answer to a particular scientific situation (b) students' ideas which causes mistaken answer about a particular scientific situation (c) students' beliefs about how the world works different than that of the scientists. Thus on the basis of above meanings and definitions the term "misconception in science" can be simply paraphrased as an idea or an explanation that differs from an accepted scientific concept. It can also be concluded that if the view or the opinion or the concept of an individual is different with what is generally accepted by scientific community the individual may tend to develop misconception. Wrong information, misunderstanding or partial understanding of scientific concepts may lead to misconceptions among students.

2.0 Statement of the Problem

"A study of misconceptions in science among students of standard VIII of Ranchi district"

2.1 Objectives of the study

1. To identify misconceptions in science among students of standard VIII.
2. To study the reasons and sources of misconceptions in science among students of standard VIII.
3. To study misconceptions in science with respect to:
    a. Gender
    b. Availability of teaching learning materials.
    c. Availability of science laboratory.
    d. Educational qualifications of teachers.
    e. Professional qualification of teachers.
    f. Experience of teachers.
    g. Educational Qualification of parents

2.2 Hypothesis

The hypotheses for the present study are as follows:

1. There will be no significance difference in the mean score of misconceptions in science between boys and girls of standard VIII.
2. There will be no significance difference between availability and non-availability of teaching learning material on misconceptions in science among students of standard VIII.
3. There will be no significance difference between availability and non-availability of science laboratory on misconceptions in science among students of standard VIII.
4. There will be no significance difference between higher educational qualification and lower educational qualification of teachers on misconceptions in science among students of standard VIII.
5. There will be no significance difference between higher professional qualification and lower professional qualification of teachers on misconceptions in science among students of standard VIII

6. There will be no significance difference between higher experience level and lower experience level of teachers on misconceptions in science among students of standard VIII.
7. There will be no significance difference between higher educational qualification and lower educational qualification of parents on misconceptions in science among students of standard VIII.

2.3 Explanation of the term

Misconception: Misconception refers to any conceptual idea whose meaning deviates from the one commonly accepted by scientific consensus (Haslam & Treagust, 1987).

2.4 Operationalization of the term

1. Misconceptions in Science: For the present study the term misconception refers to the incorrect answer given by the students in Three-Tiered Multiple Choice Science Misconception Test (TTMCSMT). Misconceptions among students can be in the form of misunderstandings, mistakes, errors, improper/partial understanding of the facts and the concepts.

2. Score on Misconceptions in Science: For the present study scores on misconceptions refers to the total achievable scores minus scores obtained by students on Three-Tiered Multiple Choices Science Misconceptions Test.

Score on Misconception = 76 - Score obtained by a student on TTMCSMT

As there were 76 items of one mark each in the test, therefore, maximum achievable score was 76.

Second tier was used to know the probable reasons of misconceptions and third tier was used to know the probable sources of misconceptions.

2.5 Delimitation of the Study

The present study was delimited to schools affiliated to Jharkhand Board of Secondary Education of Ranchi district. The present study was further delimited to standard VIII students enrolled in the academic year 2019-2020. It was also delimited to scientific concepts only.

3.0 Methodology of the Study

A descriptive survey method was used for the present study.

3.1 Population

The population for the present study consists of all the schools affiliated to Jharkhand Board of Secondary Education of Ranchi district of Jharkhand state.

3.2 Sample and Sampling Technique

There were a total of 18 blocks in Ranchi district. One school from each block was selected using lottery method.

3.3 Tools used for Data Collection

To collect the data on Misconceptions in Science following tools were used.

1. Content analysis of Science and technology textbook of standard VIII of Jharkhand State Board.
2. Semi-Structured Interview for school teachers.
3. Three-tiered Multiple Choices Science Misconception Test.
4. Information Schedule for school teachers.
5. Observation Schedule for availability of teaching learning material.
6. Observation Schedule for availability of science laboratory.

3.4 Data Analysis

Data analysis of scores of students in Three-Tiered Multiple Choice Science Misconception Test was done by frequency and percentage. Hypotheses were tested through independent t-test and one way ANOVA and decisions regarding rejection of the hypotheses were taken accordingly.

4.0 Major Findings

1. It was found that majority (64.80 %) of students had given incorrect answers of the true and false questions in Three-Tiered Multiple Choice Science Misconception Test.

2. It was found that majority (83.40 %) of students had given incorrect reasons for their true and false answers of Three- Tiered Multiple Choice Science Misconception Test.
3. It was found that majority of the students who had given correct answers (35.20 %) of their true and false questions in the first tier of Three-Tiered Multiple Choice Science Misconception Test has given incorrect reasons (73.73 %) in the second tier of Three-Tiered Multiple Choice science Misconception Test.
4. It was found that less percentage of students who had incorrect answers (64.80 %) of their true and false questions in the first tier of Three-Tiered Multiple Choice Science Misconception Test has given correct reasons (11.30 %) in the second tier of Three-Tiered Multiple Choice science Misconception Test.
5. It was found that (65.09 %) of students had given incorrect answers in Physics.
6. It was found that (66.29 %) of students had given incorrect answers in Chemistry.
7. It was found that (63.18 %) of students had given incorrect answers in Biology.
8. It was found that (83.65 %) of students had given incorrect reasons in Physics.
9. It was found that (84.99 %) of students had given incorrect reasons in Chemistry.
10. It was found that (81.47 %) of students had given incorrect reasons in Biology.
11. It was found that majority (57.44 %) of students had given incorrect answers along with incorrect reasons. Thus, (57.44 %) of students had complete misunderstanding of scientific concepts or misconceptions in science.
12. It was found that (33.30 %) of the students had given either correct answers along with incorrect reasons or incorrect answers along with correct reasons. Thus, (33.30 %) of students had partial understanding of scientific concepts.
13. It was found that less percentage (9.26 %) of students had given correct answers along with correct reasons. Thus (9.26 %) of students had complete understanding of scientific concepts.
14. It was found that (53.37 %) of the students who had complete understanding considered books as their primary source of knowledge.
15. It was found that (30.17 %) of the students who had complete understanding considered teachers as their primary source of knowledge.
16. It was found that (4.25 %) of the students who had complete understanding considered peers as their primary source of knowledge.
17. It was found that (5.82 %) of the students who had complete understanding considered parents as their primary source of knowledge.

18. It was found that (6.37 %) of the students who had complete understanding considered their observations and their experiences as their primary source of knowledge.
19. It was found that (61.29 %) of the students who had partial understanding considered books as their primary source of knowledge.
20. It was found that (30.35 %) of the students who had partial understanding considered teachers as their primary source of knowledge.
21. It was found that (3.88 %) of the students who had partial understanding considered peers as their primary source of knowledge.
22. It was found that (1.62%) of the students who had partial understanding considered parents as their primary source of knowledge.
23. It was found that (2.84 %) of the students who had partial understanding considered their observations and their experiences as their primary source of knowledge.
24. It was found that (64.16 %) of the students who had complete misunderstanding or misconceptions considered books as their primary source of knowledge.
25. It was found that (29.45 %) of the students who had complete misunderstanding or misconceptions considered teachers as their primary source of knowledge.
26. It was found that (3.57 %) of the students who had complete misunderstanding or misconceptions considered peers as their primary source of knowledge.
27. It was found that (1.20 %) of the students who had complete misunderstanding or misconceptions considered parents as their primary source of knowledge.
28. It was found that (1.60 %) of the students who had complete misunderstanding or misconceptions considered their observations and their experiences as their primary source of knowledge.
29. It was found that there was no significant difference in the mean score of misconceptions in science between boys and girls.
30. It was found that availability and non availability of teaching learning material has significant difference on misconceptions in science among students. It was found that higher the number of teaching learning materials lower is the level of misconceptions among students.
31. The significance difference between availability and non-availability of science laboratory on misconceptions in science among students could not be established because science laboratory was available in only one school.

32. It was found that there was no significant difference between higher and lower level of educational qualification of teachers on misconceptions in science among students.
33. It was found that there was a significant difference between higher and lower level of professional qualification of teachers on misconceptions in science among students. It was found that higher the professional qualification of teachers lower is the level of misconceptions among their students.
34. It was found that there was a significant difference between higher and lower experience level of teachers on misconceptions in science among students. It was found that higher the experience of teachers lower is the level of misconceptions among their students.
35. It was found that there was a significant difference between higher and lower level of educational qualification of parents on misconceptions in science among students. It was found that higher the educational qualification of parents lower is the level of misconceptions among their children.

4.1 Discussion

The present study findings revealed that majority of the students around (91 %) had either misconceptions in science or had partial understanding of scientific concepts. Similar kind of result can be found from the study of Haslam and Treagust (1987) who found that a very high percentage of students had misconceptions in science. Dreyfus and Jungwirth (1989), Odom, et. al., (1995), Seaner & Eryilmaz (2004) also found that majority of students had misconceptions in science. Bethard, et. al., (2006) in their study found that majority of middle and high school students had misconceptions in science. Akhilesh (2014) conducted a study on identification of misconception in Physics among VIII standard students in Kerala. The researcher has found that all the students possess high rate of misconceptions in all the major concepts of Physics. Dharan (2015) conducted a study on identification and remediation of misconceptions about chemical kinetics among secondary school students. The researcher has found that majority of students have misconceptions in different concepts of chemical kinetics. Hasiloglu and Eminoglu (2017) in their study found that majority of students had cell related misconceptions.

In the present study it was found that majority of the students (65 %) who had either partial understanding or misconceptions in science considered textbooks are their primary source of knowledge. Similar kind of result can be seen from the study conducted by Cho, et. al., (1985) who found that high school biology text books as the primary source of misconceptions among students. Pearson & Hughes (1988) found that technical vocabulary of genetics as a source of error and confusion and reported misuse of terms in textbooks as the primary source of misconceptions among students. Sanger (1997) and Soyiba (2008) also found textbooks as the possible source of misconceptions among students. King (2009) had done "An Analysis of Misconceptions in Science Textbooks: Earth science in England and Wales". The 29 science textbooks or textbook series surveyed (51 texts in all) showed poor coverage of National Curriculum earth science and contained a mean level of one earth science error/misconception per page. Science syllabuses and examinations surveyed also showed errors/misconceptions. More than 500 instances of misconception were identified through the surveys. Segedinac and Horvart (2016) found that imprecise use of language in Chemistry textbook as a major source of misconceptions in science among students. Zajkov, et. al., (2017) conducted a study on textbook caused misconceptions among grade 8 Physics students. The findings revealed that errors were found from both a didactic as well as from physical point of view.

The present study findings revealed that there was no significant difference in the mean scores of misconceptions in science between boys and girls of standard VIII. Similar kind of result can be seen from the study conducted by Sopapun (1994) who found that gender did not had significant effect upon misconceptions in science among 8^{th} grade students. Taylor et. al., (2009) in their study found that there were no significant difference between the women and men regardless of whether their answers were confidently correct or incorrect, suggesting that gender has no effect upon misconceptions in science among students.

In the present study it was found that higher the educational qualification of parents lower is the level of misconceptions among their children. Similar kind of result can be seen from the study of Tangmongkollert (1994) who found that parents' educational level has direct impact on their children's understanding. The researcher has found that the students whose parents had completed college education scored significantly higher than those whose parents had completed lower educational levels.

4.2 Implications of the Present Study

Following implications can be drawn from this study and this may require considerable changes from school teachers to the policy makers.

1. The teachers should plan their lesson keeping in mind the nature of the scientific concepts which they are going to teach. Abstract concepts should be concretized through the judicious use of teaching learning materials as well as making proper connections to the real life experiences of the students.
2. It has been observed that the printing quality of the textbook is not up to the mark. Diagrams need to be more clear and proper labelling should be done. For example, the diagram of cork cell, onion cell, cheek cell, plant cell, animal cell, nucleus, E.Coli is not clear. The labelling of diagram depicting the flow of water from the beaker at different levels is not done. This can create confusion among students that at which level water exerts more pressure. It has also been observed that the manner in which textbook is written can also cause misconception. For example, it has been written that metals are generally brown in colour except gold which is yellow and copper which is slightly reddish in colour but metals like aluminium, sodium, mercury and silver are whitish in colour is not mentioned in the book.
3. It has been observed that parents can relay their misconceptions to the students. Many a times adults don't have an idea that what they "know" is actually a misconception. This knowledge equips the teachers to plan their lessons well so that commonly occurring misconceptions can be refuted.
4. For each topic the teacher should adopt proper method of instruction so as to reduce misconceptions among students.
5. In order to reduce the occurrence of misconceptions among students it is better to analyze their previous knowledge and every day experiences and remediation should be done if required before teaching every topic.
6. Teachers should ensure that students do not over generalize principles as it is a major barrier in understanding new concepts.
7. While teachers plan and develop instructional materials, they should be aware of students' misconceptions and their influence in learning.
8. The teachers should be given proper orientation regarding identification of misconceptions in science among students and the ways to refute it.

9. Teachers should be aware that students will hold on to their misconceptions if taught only through lecture method.
10. The teachers should conduct more of experiments, demonstrations and hands on activities in the classroom which helps in the development of correct understanding of concepts.
11. Frequent in-service training of the science teachers should be conducted where teaching strategies that help students learn science meaningfully should be discussed.
12. Teachers should also be aware of all the possible sources that may cause misconceptions among students.
13. In many of the researches it has been found that teachers themselves are one of the possible sources of misconceptions among students, therefore, they should be careful in planning their lessons and their instructions.
14. School administrations should conduct workshops where experts in the field of science education can enrich teachers to use conceptual change approaches in their teaching.
15. Content developers and textbook writers should also be aware about the possible sources and causes of misconceptions among students.

4.3 Suggestions for Further Research

Every research work gives insight to other researchers for further investigation. This study suggests certain areas which can be further investigated. These areas are as follows:

1. A set of diagnostic studies can be conducted to identify misconceptions in science among students.
2. Qualitative studies on small groups can be conducted for in depth understanding of misconceptions in science among students.
3. Experimental studies can be conducted to identify misconceptions in science among students.
4. Similar studies can be conducted exclusively for the concepts of Physics, Chemistry and Biology separately.
5. Similar studies can be conducted using different tools such as four-tier test, five-tier test, conceptual understanding scale, concept inventory test, concept maps, concept cartoons etc.

6. Similar studies can be conducted on students other than standard VIII.
7. Studies can be done where researchers can identify student's misconception and those identified misconceptions should be refuted through the use of refutational texts, role plays, storytelling, and virtual science laboratory etc.
8. Studies can be conducted on teachers to check how far teachers have misconceptions in science.
9. Studies can be conducted on parents to check how far parents have misconceptions in science.
10. Studies can be conducted on science textbooks to check whether the contents of the textbooks can create misconceptions among students.
11. Studies can be conducted to identify the probable causes of misconceptions in science among students.
12. Studies can be conducted to identify different types of misconceptions in science such as preconceived notions, vernacular misconceptions, conceptual and factual misunderstandings.

4.4 Recommendations

The researcher has suggested following recommendations in order to reduce the occurrence of misconceptions in science among students**:**

1. Teachers need to emphasize more on transacting scientifically correct concepts to students rather than focusing more on rote learning and memorization.
2. Misconceptions in science cannot be refuted through chalk and talk method, therefore teachers need to engage the students in different learning environments and learning experiences such as experiments, activities, field trip, multimedia, theatre, role play, demonstration, group discussion and investigations etc inside and outside the classroom for developing correct and concrete understanding of concepts, and promote interest and attitude towards science.
3. Teaching of science should be based more on real life experiences and observations of the students.
4. It is very essential that schools should have adequate equipment facilities as well as laboratory facilities for the students to carryout experiments and activities regularly so that students employ their sensory organs which would help them to enhance their understanding.

5. Teaching of science should provide opportunity for the students to use scientific equipments such as microscope, magnifying lens, simple pendulum etc.
6. It is recommended that scientific terms, definitions and key words should be included at the end of the lesson to make it easier for students to recapitulate the lesson.
7. It is recommended that link of educational websites should be provided at the end of the every lesson where students can get ready-made material for a particular concept which can help in the enhancement of concept clarity of the students.
8. It is recommended that a CD should be attached for the explanation of different scientific phenomenon which may prove beneficial to both students and teachers.
9. It is recommended that the physical features of the book need to be improved such as cover page, pictures and diagrams on different pages, paper quality.
10. The Government of Jharkhand should organize frequent in-service training for science teachers where they are taught to conduct simple but effective experiments in the classroom. They can also be trained on how to make low-cost but effective teaching learning materials, as well as teaching aids from waste materials or locally available materials**.**
11. The Government of Jharkhand should organize frequent workshops where teachers from different schools should discuss about the problems they face while teaching. The teachers should also discuss about the probable solutions to the problems which they could implement in their classroom for further improvement of teaching learning process. As a result the teachers could gain fruitful knowledge.
12. Textbook plays an important role in teaching learning process as it occupies a unique position as it addresses the students' needs and is used by the teachers as the most important and vital instructional material. Thus, The Government of Jharkhand should keep in mind that textbooks once made should not be considered final for all times to come but should be evaluated from time to time to keep the pace with the changing world.

Science is an organized system of knowledge which provides the methods and necessary tools to explore and understand the world. One of the important aspects of

science education is to transact scientifically correct concepts to students. Concepts by themselves are abstract. They need to be presented to students though content that helps them connect the concept with their previous knowledge as well as with their observations and experiences in the real world. Incorrect or partially correct concepts may tend to develop misconceptions among students. On the basis of the findings of the study it can be concluded that misconceptions in science is prevalent at a higher extend among students. Misconceptions in science among students can stem from variety of factors such as textbooks, improper instructional practices, and lack of hands-on experiments, over or under simplification of scientific concepts, misinterpretation of scientific concepts leading to incomplete or incorrect understandings. With all the considerations and observations we can arrive at a point that it is crucial to address these misconceptions in order to foster a better understanding and appreciation of the scientific method and its contributions to our understanding of the natural world.