CHAPTER V

SUMMARY, FINDINGS, DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

5.0 Introduction

According to Frederick Fizpatrick (1960) "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". It has also been found in the document of NCF (2023) that 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.

Science education is considered important both before independence as well as after independence. British government also laid emphasis on the importance of imparting science education to students. Science is involved in almost all the activities of our day to day life so the learners must have correct understanding of scientific concepts otherwise lack of concept clarity may lead to misconceptions. National Focus Group on Teaching of Science (2005) suggests that scientific concepts should be taught mainly through activities, experiments and hands on experiences at all stages whether primary, upper primary, secondary or higher secondary levels. However, some researches such as Padhi (1994), Maitra and Maitra (1997), Malhotra (1998), Umashree (1999), Saxena (2012), Shelat (2013) found that science is taught more through lecture method rather than through demonstration or experiments. Malhotra (1998) observed that teachers often provide lecture and students largely observe the teacher rather than actively

participating in the classroom. Umashree (1999) found that students are rarely given opportunities to do things or take initiatives; teachers simply teach science through lecture method. Science is more about doing rather than cramming. If science is taught more through lecture method rather than demonstration method then students will not be able to understand the abstract concepts correctly and as a result misconceptions are created. Science teaching should engage the learner in acquiring methods and processes that will nurture the curiosity and creativity particularly in relation to the environment. It should develop the ability to think logically and the ability for using scientific method of work. Overall there is a need to develop teaching style and strategy to ensure meaningful learning so that correct scientific concepts are developed and misconceptions are avoided. Therefore, it is of utmost importance that the misconceptions among students must be identified then only proper teaching learning strategies can be developed to minimize it. Hence the researcher has decided to conduct a study on misconceptions in science with the following research questions.

1. How misconceptions in science can be measured?
2. What leads to the development of misconceptions in science among students?

5.1 Statement of the Problem

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

5.2 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

5.3 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 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.

5.4 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). According to Guest (2003), when children hold views that differ from conventional scientific explanations or classifications they are often referred to as misconceptions. For the present study, the definition provided by Narode (1987) is sufficiently comprehensive to provide practical and useful guidelines: Misconception is a person's conceptualization of a problem or phenomenon that generally is reasonable to themselves but at variance from the conceptualization of an "expert" in the field from

which the problem came. Thus, the term misconception can be simply paraphrased as an idea or an explanation that differs from an accepted scientific concept.

5.5 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.

5.6 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 year 2019-2020. It was also delimited to scientific concepts only.

5.7 Methodology of the Study

A descriptive survey method was used for the present study. According to Creswell (1994), the descriptive research method gathers information about the present condition. The focus of this research was to identify misconceptions in science, and therefore, the descriptive survey method was appropriate.

5.7.1 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. There were a total of 866 schools under Ranchi district. All standard VIII students and teachers teaching science to these students of the academic year 2019-2020, constituted the population for the present study.

(Source: District Education Office, Ranchi)

5.7.2 Sample and Sampling Technique

For the present study the sample was selected from Ranchi District of Jharkhand State. There were a total of 18 blocks in Ranchi district. One school from each block was selected using lottery method. All the students of standard VIII and teachers teaching science to the students of the selected schools constituted the sample for the study. There were a total of 926 students and 18 teachers.

5.7.3 Tools used for Data Collection

In order to collect the requisite data for any theme of research, one has to devise an appropriate tool. To collect the data on Misconceptions in Science following tools were used.

1. Content analysis of Science & 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.

5.7.3.1 Content Analysis of Science and Technology Textbook of Standard VIII of Jharkhand State Board

The researcher has done the content analysis of science and technology textbook of standard VIII of Jharkhand State Board. The objective of the text book analysis was to know the content, topics and concepts covered in each chapter. There were a total of 16

chapters in the book. Text book analysis helped the researcher to identify the proper representation of chapters of physical and biological sciences. It also helped the researcher to figure out the inter-linkages between the chapters and its gradual progression from easy to difficult concepts. The detailed analysis of science and technology text books of standard VIII helped the researcher to establish vertical and horizontal relationship among chapters. The scientific concepts or topics covered in each chapter would become the base for the construction of Three-Tiered Multiple Choice Science Misconception Test.

5.7.3.2 Semi Structured Interview of School Teachers

The researcher has taken semi structured interview of school teachers who taught science to the students of standard VIII in Jharkhand State Board Schools. The researcher has conducted the interview of 25 teachers teaching science in different schools. Most of the teachers had a minimum of 10-15 years of teaching experience. The objective of this interview was to identify those concepts where students face difficulty in comprehension. During interview discussion was also done related to concepts where teachers face difficulty in making students comprehend in spite of all their efforts.

5.7.3.3 Principles Followed While Constructing Three-tiered Multiple Choice Science Misconception Test

On basis of text book analysis, semi structured interview of school teachers and personal teaching experience the researcher has identified one chapter each from physics, chemistry and biology for the construction of Three-Tiered Multiple Choice Science Misconception Test. Prior to the construction of the test the researcher had carefully reviewed the existing research literature, as well as all related instruments that have already been used by other researchers on misconceptions in science. Language used in the tool should be simple and understandable by the students.

5.7.3.4 Three-tiered Multiple Choice Science Misconception Test

In order to collect the data on misconceptions in science from the selected sample, researcher constructed the Three-tiered Multiple Choice Science Misconception Test for the students of standard eight. This test contained a set of items, each one composed of

three parts. The first part or the first tier of the item is multiple choice content questions with a set of true and false responses. The second part or the second tier consists of a set of justifications for the chosen response to the question in the first part. Space is provided for writing an alternative response. The third part or the third tier consists of set sources of the information. By considering the study objectives, research questions, nature of date required, and student's cognitive level, researcher has constructed the first draft of the three-tiered multiple choice science misconception test.

5.7.3.5 Expert's Validation

The item pool of Three-tiered Multiple Choice Science Misconception Test was sent to experts in the field of science and technology to ensure its content validity and appropriateness of items. The experts were either working as a science teacher in elementary/secondary/higher secondary schools or assistant professor of science method in teacher education institutes. The minimum qualification of the experts was M. Sc., B.Ed. However, some experts had the qualification M. Sc., M. Ed. while many of them had earned a Ph. D. in Education too. The minimum teaching experience of the experts was five years; however, some experts had a vast experience of 25 years too. The tool was also sent to English and Hindi language experts to examine its language aspects. The comments and suggestions received from the experts were incorporated to formulate the final draft of the test.

5.7.3.6 Pilot Testing

Researcher had personally administered the Three-tiered Multiple Choice Science Misconceptions test on a group of 45 students who were not the part of the sample. The main purpose of pilot testing was to examine the tool of its language aspect and ambiguity of the items. According to Johnson and Christensen (2008) a pilot testing of minimum five to ten pupils is enough to establish the reliability of the tool. Subsequent to completion of pilot test researcher has used "Think aloud Technique" to know strength and weakness of the items. In this technique the participants verbalize their suggestions and perceptions about each item. Think aloud technique is for determining whether participants are interpreting the items the way researcher has intended (Johnson and Christensen, 2008). Instead of using the "Think aloud Technique" on all the 45 students, it was rather used on a small group of 15 students so that the researcher can

more accurately figure out whether the students are interpreting the items, the way researcher has intended.

Experts' comments and suggestions during validation of the item pool and the findings of the pilot testing were used to frame the final draft of the test. In the final draft some items were substituted, some were deleted and few were modified.

5.7.3.7 Information Schedule for School Teachers

The researcher has made an information schedule for the teachers to know about their gender, teaching experiences, educational qualification, professional qualifications, and mode of teaching, use of teaching learning materials in the classroom. This tool was administered on 18 science teachers teaching students of standard VIII in schools of Ranchi district.

5.7.3.8 Observation Schedule for Availability of Teaching Learning Materials

The researcher has made an observation schedule to check the availability of teaching learning materials in the selected schools. This observation schedule has six items. These items were kept in the tool to assess the availability of books, blackboard along with the presence and use of charts/models/diagrams in the classroom. The researcher also observed the availability of electricity so that the use of information and communication technology can be assessed. The observation regarding availability and use of teaching learning material in the classroom was noted in the field diary.

5.7.3.9 Observation Schedule for Availability of Science Laboratory

The researcher has made an observation schedule to check the availability and use of science laboratory for teaching-learning process. The researcher was keen to observe that whether science laboratory was well illuminated and ventilated so that the students feel comfortable and there is no difficulty in performing any experiments. The tool contained ten items related to the availability and working condition of the scientific equipments. The equipments were in accordance to the needs of the student and whether it was used by teachers only or students were also allowed to manipulate with the equipments. Items related to the proper allocation of equipments to the students as well

as the presence of sufficient number of equipments were also added in the tool. The observation regarding availability and use of science laboratory was noted in the field diary.

5.8 Procedure for Data Collection

First the researcher has taken a permission letter from guide for data collection. Then a forwarding letter was taken from the Dean and Head of The Faculty of Education and Psychology, Department of Education (CASE) The Maharaja Sayajirao University of Baroda. This forwarding letter was presented to the District Superintendent of Education (DSE) of the Ranchi District. Thereafter permission letter was sought from the DSE of Ranchi district to allow the researcher to collect data in the selected schools. The tools used for data collection was also submitted to the office of the District Superintendant of Education and an assurance was given that data collected would be used for research purpose only and would be kept strictly confidential. Students were instructed to fill primary details such as their names, school names, class section, before they started attempting the questions. Following instructions were given to the students before starting of the test.

- It is compulsory to attempt all the questions.
- Each question has three parts.
- Put a tick mark to the most appropriate response from each part.
- Each question has only one correct answer.
- There is no negative marking for incorrect answer.
- Each correct answer carries one mark.
- Do not make any marks in the question paper.
- Return the question paper to the invigilators after completion of the test.

5.9 Data Analysis Techniques

The tools used to gather data for each objective along with the appropriate data analysis techniques employed for each tool is depicted in the table given 5.1

Table_5.1 Tools and Data Analysis Technique

S.N.	Objectives	Tools Used for Data Collection	Data Analysis Technique Employed
1.	To identify misconceptions in science among students of standard VIII.	Three-tiered Multiple Choice Science Misconceptions Test	Percentage
2.	To study the causes and sources of misconceptions in science among students of standard VIII.	Three-tiered Multiple Choice Science Misconceptions Test	Frequency and Percentage
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 qualifications of parents	Three-tiered Multiple Choice Science Misconceptions Test for variable **a** & **g**, Observation Schedule for variable **b & c** Information Schedule for teachers for variable **d, e & f.**	t-test, ANOVA

5.10 Major Findings

The major findings of the study are as follows:

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 levels 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.

5.11 Discussion

Science is an organized system of knowledge, which evolved as a result of curiosity, inquiry, logical reasoning, experimentation and examination of empirical evidence. Science provides the methods and necessary tools to explore and understand the world. Science teaching should provide rich learning experiences to learner. Learning becomes concrete and meaningful only when there is interplay between learner and learning experiences. If it fails to provide such opportunity for the students, then the learning becomes mechanical and monotonous. Present science teaching in schools is largely dominated by textbooks (Umashree 1999, Oglesby 2010, Shelat 2013). Teacher continuously delivers content into students' minds which they often end up memorising the concepts without understanding it. NCF (2005) suggested content validity is one of the basic criteria for science curriculum and it demands that science curriculum must convey significant and scientifically correct content. The content presented in the curriculum is not just for memorisation, it is for comprehension.

According to NCF (2023), the major challenge related to science in the school curriculum is neglect of the development of conceptual understanding and the process capacities of doing science. Science teaching-learning is mostly based on the textbook, with the focus on facts and definitions. The development of conceptual understanding is currently missing. Another challenge is the disconnection between what students observe and experience outside school and the school curriculum. 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. Identification of misconceptions in science among students is essential for promoting accurate knowledge, scientific literacy, critical thinking, informed decision-making and countering the spread of misinformation.

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.

On the basis of the findings of the study it can be concluded that misconceptions in science is prevalent among majority of the students. Most of the students considered books as the primary source of knowledge followed by teachers. Less percentage of students considers peers, parents, observations/experiences as their primary source of knowledge. Gender as well as educational qualification of teachers did not have any significant impact on misconceptions in science among students. Students who had been taught through the use of charts/diagrams had better concept clarity in comparison to students who were simply taught through chalk and talk method. It was found that higher the professional qualification of teachers lesser is the level of misconceptions

among their students. The study also revealed that the experience of teachers had a significant impact upon student's misconceptions. Higher the experience level of teachers lesser is the level of misconceptions among their students. Last but not least, it was also found that the educational qualification of parents also had a significant impact upon their children's misconceptions. Higher level of misconceptions was found among students whose parents were uneducated in comparison to parents whose qualification was PG and above.

It was found that none of the schools had science laboratory except one. Even in one of the schools where science laboratory was available students were seldom allowed to visit it. Most of the time students listened to science teacher's lecture wherein teachers read and explain the scientific concepts and definitions. The teachers very rarely demonstrated the experiments in the classroom and students did not do any science experiment in classroom or laboratory on their own either in groups or individually. The students had not operated microscope. They had neither observed any preserved specimens nor any chemicals in the laboratory. Students had not even used simple equipments and apparatus such as magnifying lens, rulers, pipette, burette, measuring cylinders, conical flasks, beakers, thermometers or even litmus papers. It was found that majority of students were not able to differentiate between force and pressure. Majority of them were not able to differentiate between attractive and repulsive forces of magnet. Majority of students had misconceptions related to pressure exerted by liquids. It was found that majority of students were not able to differentiate between metals and non-metals. It was found that majority of the students were not able to differentiate between plant cell and an animal cell. It was found that in majority of the schools the teaching was mostly done through lecture method. Teachers seldom use Teaching Learning Materials to teach abstract concepts of science. Moreover teachers hardly try to connect the concepts of science to the real life experiences of the students.

According to Allen (2004) picture and diagrams plays an important role in concept building of students. Through the content analysis of science and technology textbook of standard VIII of Jharkhand board it has been found that most of the diagrams were not clear, in some the labelling was not done properly. For example the picture (pic-1.12) illucidating the difference between a plant cell and an animal cell is not clear The basic difference between a plant cell and an animal cell is that the former has a large

single vacuole where as the latter has numerous small vacuoles but it the picture it is not at all clearly visible. This could be a probable reason for lack of concept clarity among students regarding plant cell and an animal cell.

Some variation has been found between present study and the literature reviewed In the present study it was found that higher percentage of students had difficulty in understanding the concepts of chemistry followed by physics and biology but it has been observed through the review of the literature that a higher percentage of students had difficulty in understanding the concepts of physics followed by biology and chemistry.

Learning science involves not just learning theories and facts of science, but also making connections between conceptual learning and real life. Learning science especially requires access to apparatus, equipment, and laboratories. Students must be able to manipulate apparatus, use materials and design simple experiments to truly develop important competencies related to science. Teachers must build an environment that promotes natural curiosity, encourages questions, and gives maximum possible opportunities for hands-on activities, and space to discuss ideas.

5.12 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 labeling 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 labeling 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.

5.13 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.

5.14 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. The Government of India should bring textbook reforms from time to time and should also conduct frequent in-service training of science teachers so that the chances of prevalence of misconceptions in science among students should be minimised. Science

teaching in school plays an important role in constructing knowledge and developing positive attitudes towards science. Learning science involves not just learning theories and facts of science, but also making connections between conceptual learning and real life, acquiring the process capacities of science, and most importantly, applying these to understanding the world.