CHAPTER I

CONCEPTUAL FRAMEWORK

1.0 Introduction

Education in the largest sense is any act or experience that has a formative effect on the mind, character or physical ability of an individual. It is the process by which society deliberately transmits accumulated knowledge, skills and values from one generation to another. The process of gaining and imparting education is spontaneous and goes on throughout our lives. As per modern conventions, education actually begins in school but in reality, it begins with the day we are born. Education that students get in the schools is through different subjects that are taught in schools. Science is one of the subjects that are compulsory taught at all levels of schooling and it is also one of the core elements of the school curriculum.

The word science derived from Latin word “Scientia” which means “to know”. In this context, science is a human enterprise through which we come to understand the big biological and physical aspects of the world around us. Science is tied to nature. Explanations of nature are always open to questions. Science is built from curiosity, experience, analysis and finally the expression of discovery. Adinarayana (1984) said “Science is better suited than any other subjects for acquiring the ability to develop scientific attitudes, to distinguish on the fact from opinion. It is important that science is highly creative and dynamic in nature by which man can attempt to search knowledge”. Science provides opportunity for an individual to develop inquiry skills, critical thinking, creativity, problem solving, decision making skills etc. National Research Council (NRC, 1996) rightly stated that “Science is a human endeavour that relies on reasoning, insight, energy skill and creativity”. “Science not only inculcates knowledge and skills to the human, it also promotes universal values to people for the betterment of society” (Patel, 1997).

As an individual and as a citizen, each of us needs science. Most people use it, or at least claim to use it regularly. But what is science? For some, it is an organised accumulation of factual information. For another, it is a series of generalizations based on the facts. It is however, much more than this. Science is a way of thinking, a way of feeling and even more important a way of behaving towards people, towards things and towards ourselves. Thus, it was rightly stated by NRC (1996) and American Association for Advancement of Science (AAAS, 1968, 1990, 1968) that scientific literacy is one of the foremost goals of science education. Nation’s vision and expectation is that everyone should become scientifically literate citizens. Considering this view educationists, policy makers and stakeholders realised that schools have prime responsibilities to prepare the children as scientifically literate citizens. It was recommended by Secondary Education Commission (1952) that the common need of middle school students in the area of science can be met best by formulating “general courses”. At the high school stage, there will be a specialised reorientation of the science courses and physics, Chemistry and Biology will be taught as independent subjects. The outcome of science teaching in schools should be make the students understand the basic scientific concepts, facts and principles, process skills/methods to develop scientific attitude, and apply the basic scientific concepts and skills in their daily life. UNESCO (1992) formally expressed the objectives for learning science as concepts, process skill and attitudes. National Education Policy (2020) suggested including teaching of science form gradually introducing the general groundwork at preparatory stage to more abstract concept at middle stage to building greater depth across all the subjects at secondary stage.

1.1 Meaning and Definition of Science

Science is the term that encompasses many fields or disciplines. The nature, structure and functions have been differently described by various scientists and philosophers. It is not easy to give precise definition of what is science. Science is a way of thinking, reasoning and finding solutions for diverse kinds of problems related to life and natural phenomenon. Scientists believe that all the natural phenomena have some patterns that can be understood through careful and systematic study. Although science does not have a single definition, however, many scientists, researchers and philosophers made attempts to define science.

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”. According to Conant (1951) “Science is an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation". Bronowski (1956) considers "science as the search for order, regularity and organization as the fundamental aspect of science". According to Columbia Encyclopaedia (1974) "science is an accumulated systemised learning in general usage restricted to natural phenomena. The process of science is marked not only an accumulation of fact but by the emergence of scientific method and of scientific attitude". According to Lederman (1992) "science is a dynamic ongoing activity rather than a static accumulation of information". However, Best and Kahn (2009) view "science as the approach to the gathering of knowledge rather than as a field or subject matter". By analysing the different definition of science, following inferences are derived:

- ❖ Science is a systematic way of acquiring knowledge. It is dynamic, tentative and not an absolute knowledge. Science is an endless series in pursuit of truth.
- ❖ Science is both a process as well as a product. The process of science is a set of skills followed by scientists or students while discovering or verifying theories and principles. Product of science includes facts, theories, laws; principles and generalisation etc. are the outcome of process.
- ❖ The process of science is given more preference than the product of science. The curious mind of human being is always in the quest of new discovery and inventions.

1.2 Importance of Science Education

Today's age is the age of science and technology. Right from cradle to grave all our activities are controlled and fashioned by science. Science has entered in our life and daily activities so much that our existence would become impossible without it. Science is a great human enterprise, not only endless and faceless but also stable and fluid. It is a self accumulating, self growing, self-pervading, self accelerating and self-correcting enterprise which originated in the collective curiosity of man science time immemorial. Science is important in everyone's life whether one knows it or not but is directly affected by it. Hence to avoid knowledge and understanding of science is to give up the right to make knowledgeable decisions about science and therefore about one's life in a society that is deeply affected by science. Science is a way of life. It is also part and parcel of life. . Every person feels the effect of science in every sphere of life. It is not merely the electric fan or the electric light, the radio or the cinema that displays the power of science in our daily life but everything we do or is done to us is in some way or another connected with science. It is comparatively easier to experience science (in our lives) than to define it. Thorough understanding and application of science eliminates the miseries of individuals and the communities as well. If science is taught and learnt effectively, individual's life will become meaningful, prosperous and productive. It will have a positive impact on the community. Therefore, it is our Nation's vision and expectation that everyone become scientifically literate citizens. Knowledge based teaching of science cannot help to achieve the benefits of science. One of the major objectives of teaching science is not only to teach content, but also to develop scientific attitude. The purpose of science education is to develop scientific literacy which is a high priority for all citizens, helping them to be interested in and understand the world around them. Science education equips an individual to engage in the discourses of and about science, to be sceptical and questioning of claims made by others about scientific matters. It also equips an individual to identify questions and draw evidence based conclusions and to make informed decisions about the environment and their own health and well being. The importance of science education is thus, coterminous with life.

1.3 Aims of Science Education

According to National Curriculum Framework for School Education (2000, 2005 & 2023) and National Focus Group on Teaching of Science (2005) the broad aims of imparting science education to learners is paraphrased as below:

- To know the facts and principles of science and its applications, consistent with the stage of cognitive development.
- To acquire the skills and understand the methods and processes that lead to generation and validation of scientific knowledge.
- To develop an understanding of how scientific knowledge evolves.
- To develop a historical and developmental perspective of science and to enable the learners to view science as a social enterprise.
- To develop an understanding of the connection between science and other curricular areas.

- To relate to the environmental (natural environment, artefacts and people), local as well as global and appreciate the issues at the interface of science, technology and society.
- To acquire the requisite theoretical knowledge and practical technological skills to enter the world of work.
- To nurture the natural curiosity, aesthetic sense and creativity in science and technology.
- To imbibe the values of honesty, cooperation, concern for life and preparation of environment and
- To cultivate scientific temper, objectivity, critical thinking and freedom from fear, superstition and prejudice.

All the aims of science education are important to develop scientific literacy but the most important is the proper and correct understanding of the facts and principles. It empowers individuals to engage with scientific concepts, make informed decisions and contribute to the progress and well-being of society. Moreover, knowledge of facts and principles of science education is also important because it helps us understand the world, develop critical thinking skills, become scientifically literate, pursue career opportunities, shape public policies, address societal challenges and foster curiosity and wonder.

1.4 Recommendations of Various Commissions on Science Education

While reviewing the recommendations of the various commissions it was found that science education is considered important both before independence as well as after independence. British government also laid the importance of imparting science education students. These recommendations can be summarised under two categories

A. Recommendations Before Independence

Macaulay's Minute on Education (1835): Lord Macaulay in his minute suggested that certain amount of money from one lakh of rupees (that was recommended in the Clause 43 of the Charter Act of 1813) should be set apart "for the introduction and promotion of a knowledge of the sciences among the inhabitants of the British territories"

Wood's Despatch (1854): Woods Despatch which is considered as the "Magna Carta" of the English Education in India also found that "the system of science and philosophy which forms the learning of the East abounds with grave errors, and Eastern literature is at best very deficient as regards all modern discovery, invention and improvements". Thus science education needs attention and promotion.

Indian Education Commission (1882-83): Indian Education Commission recommended the encouragement of science education at primary, secondary and higher education level through indigenous institutions.

Zakir Hussain Committee (1938): Zakir Hussain Committee recommended inclusion of general science in the curriculum was recommended in order to foster scientific temper among children. Science education would help in inculcation of accurate observation skills and of testing experience by experiments.

Sargent Report (1944): Sargent Report recommended about the inclusion of pure sciences and applied sciences at high school level.

B. Recommendations After Independence

Secondary Education Commission (1952-53): It suggested compulsory inclusion of General Science at middle and secondary level. It also suggested diversification of courses having science group subjects as optional channels at higher secondary level. As a result of the above recommendation, science has been recognized as a compulsory subject at all levels of schooling. It further recommended that emphasis teaching should shift from verbalization and memorisation to learning through purposeful, concrete and realistic situations and for this the principles of activity method and project method should be assimilated.

Tara Devi Report (1956): Recommended that children should be inspired by stories about scientists and their discoveries. Children should develop the ability to reach scientific generalization and to apply science for solving their day to day problems.

Education and National Development (1964-1966) has pointed out that our science education is in bad shape and it will become worse if we fail to reckon with the explosion of knowledge. So, it was suggested that the method of science teaching should be modified stressing investigatory approach and more emphasis should be given on the understanding of basic concepts. It also advocated that science is an important element in the school curriculum, further recommended that science and mathematics should be taught on a compulsory basis to all pupils as a part of general education during the first ten years of schooling and recommendations were implemented in 1975 when Science for All (SFA) was introduced as a part of general education during the first ten years of schooling with this 10+2+3 education scheme started with an additional year of schooling in the country. It further stated that science education in school is dull and uninspiring and still confronts to a mechanical routine dominated by verbalism. Even where the laboratory work is taught the approach is confirmatory and not investigatory and the emphasis should shift from confirmatory to investigatory so as to equip children in the techniques of acquiring knowledge by themselves.

The National Policy on Education (1968) stressed on the importance of quality in science education. One of the most significant developments is that science was incorporated as a compulsory subject.

Curriculum for Ten Years School: A Framework (1975) recommended that science should be one of the compulsory subjects for all students upto class X, as a part of general education. The teaching of Science and Mathematics will have to be upgraded and the curriculum continually renewed in order to give our children modern knowledge, develop their curiosity, teach them scientific method of inquiry and prepare them for competent participation in a changing society and culture , increasingly dependent on a rational outlook leading to better utilization of science and technology.

Ishwarbhai Patel Commission (1977): Recommended that children should develop observational and experimentation skills in the area of natural science. The habit of self learning from nature should be inculcated in students from childhood.

The National Policy on Education (1986) has reiterated the importance of inculcation of scientific temper among students. In order to improve science education certain provision such as provision of science kits, science equipment etc are provided to schools.

Curriculum for Elementary and Secondary Education: a Framework (1988) pointed out that science should be treated as one of the curricular areas that play a decisive role in equipping the learner for understanding with a more scientific way, various things or phenomena around him/her. Education in science should aim at developing well defined abilities in cognitive, affective and psychomotor domains such as spirit of inquiry, creativity, objectivity, the courage to question and aesthetic sensibility.

Report of National Advisory Committee on Learning without Burden (1992-1993). In this report Professor Yash Pal observed that our textbooks appear to have been written primarily to convey information or facts rather than make children think and explore. Transmission of information rather than experimentation or exploration or observation characterises the teaching process in most of the classrooms.

National Curriculum Framework (2000) recommended that children should understand some basic principles and laws of science and develop the ability to apply appropriate concepts of science.

Indian National Science Academy (2002) emphasise that science education must evoke the natural curiosity of the child, the wonderment of nature. For this the education and its tool should be fashioned to the environment in which the child lives. The child should be encouraged to find one's own answers with textbook being only guide.

National Science Survey NSS, India Science Report (2004) emphasised that science education needs to be strengthened in terms of methods of teaching, teacher's quality and infrastructure. This observation has been found valid for all regions of the country.

National Curriculum Framework (2005): It recommended that content, process and language of science teaching must be commensurate with the learning age-range and cognitive reach. Science teaching should engage the learners in acquiring methods and processes that will nurture their curiosity and creativity particularly in relation to environment. The learners should be engaged in construction of knowledge and creativity. It further emphasised that for any qualitative change from the present situation, science education in India must undergo a paradigm shift. Rote learning should be discouraged. School should give much greater emphasis on co-curricular and extracurricular elements aimed at stimulating investigative ability, inventiveness and creativity, even if these elements are not part of external examination system.

National Curriculum Framework Review (2005): The review committee recommended that curriculum must convey significant and scientifically correct content. Simplification of content, which is often necessary to adapt the curriculum to the cognitive level of the learner, must not be so trivialized as to convey something basically flawed and/or meaningless.

It can be seen that the entire above mentioned documents considers science as an inseparable part of school curriculum.

National Policy on Education (2020): National Education Policy (2020) suggested to include teaching of science form gradually introducing the general groundwork at preparatory stage to more abstract concept at middle stage to building greater depth across all the subjects at secondary stage.

National Curriculum Framework (2023): Suggested that at all stages, the conceptual understanding, along with the process capacities of science should be developed among students.

The major crux of all these commissions was to enhance the quality of science education, development of analytical, critical and creative thinking. It also emphasised on problem solving ability, scientific attitude, decision making skills, proper understanding of scientific concepts and nurturing of science process skills etc. 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.

1.5 Status of Science Teaching in India

An important purpose of science teaching is to familiarise the learners about various dimensions of scientific literacy such as understanding the nature of science, ability to apprehend basic scientific concepts, to interrelate the basic concepts with the newer concepts, development of scientific attitude and to understand science more as a process rather than a product so that the learners can apply scientific knowledge in their day to day life. 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. Experiments are the hallmark of science and for science learning they are essential. 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) in her study found that students are rarely given opportunities to do things or take initiatives; teachers simply teach science through lecture method**.** Shelat (2013) is of the view that still today science is either taught through lecture method or through “TU PADH” approach. The term “TU PADH” coined by Shelat meant that “in the science classes observed by her the students were simply asked to read and comprehend the concepts on their own”. Veerappa in the year 1958 suggested that in India like U.K and U.S.A science should be taught through concept based approach but still it is taught through lecture method. Khalwania (1986) found that concept based curriculum helped in better development of abstract concepts in children in comparison to conventional curriculum. The findings of the Public Report on Basic Education (1996 & 1998) revealed that science was taught more through lecture method rather than through demonstration or enquiry method. Students were forced to cram the topics rather than developing proper understanding of the concepts. An endearing story was told about a Standard IV class in progress in a municipal school in central Delhi. Students were mechanically being made to recite a lesson on the properties of air. The researcher visiting the classroom asks the children in a friendly way, ‘Air is everywhere. Is it, really? Is there air in your bag?’ The response of the students to this question is described as follows: Most deny emphatically, quite possessively confident of the details of their own belongings. However, a few curious and enterprising ones do innocently peep into their school bags to see if this unknown elusive element somehow entered unnoticed. Programme for International Student Assessment (PISA 2009) was the litmus test for Indian Education System. This test is conducted worldwide every three years to measure the scholastic performance of fifteen year old school pupils in Maths, Science and Reading. The two best performing states of India (Himachal Pradesh and Tamil Nadu) participated first time in PISA (2009) test. In science the result was worst, Himachal Pradesh came in dead last behind Kyrgyzstan while Tamil Nadu inched ahead to finish 72^{nd} out of 74 countries. In 2022 also India planned to participate in PISA but unfortunately we could not make it. These finding revealed a very dismal picture of science education in India. According to NCF (2005) looking at the complex scenario of science education in India three issues stand out clearly.

- Science education is still far from achieving the goal of equity enshrined in our constitution.
- Science education in India, even at its best, develops competence but does not encourage inventiveness and creativity.
- The over powering examination system is basic to most, if not all, the foundation problems of science education in India.

Looking at the contemporary scenario of science education in schools, the issues and challenges are more with regard to instructional method, laboratory and equipments facilities, curriculum materials and evaluation system. Science teaching largely follows lecture method; occasionally demonstration is conducted in the classroom and laboratory. Science teaching is dominated by facts, concepts, principles and generalisation. Even today science teaching is focussed more on content aspect rather than on process and application aspect. Teachers very rigidly conduct experiments and investigations. 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.

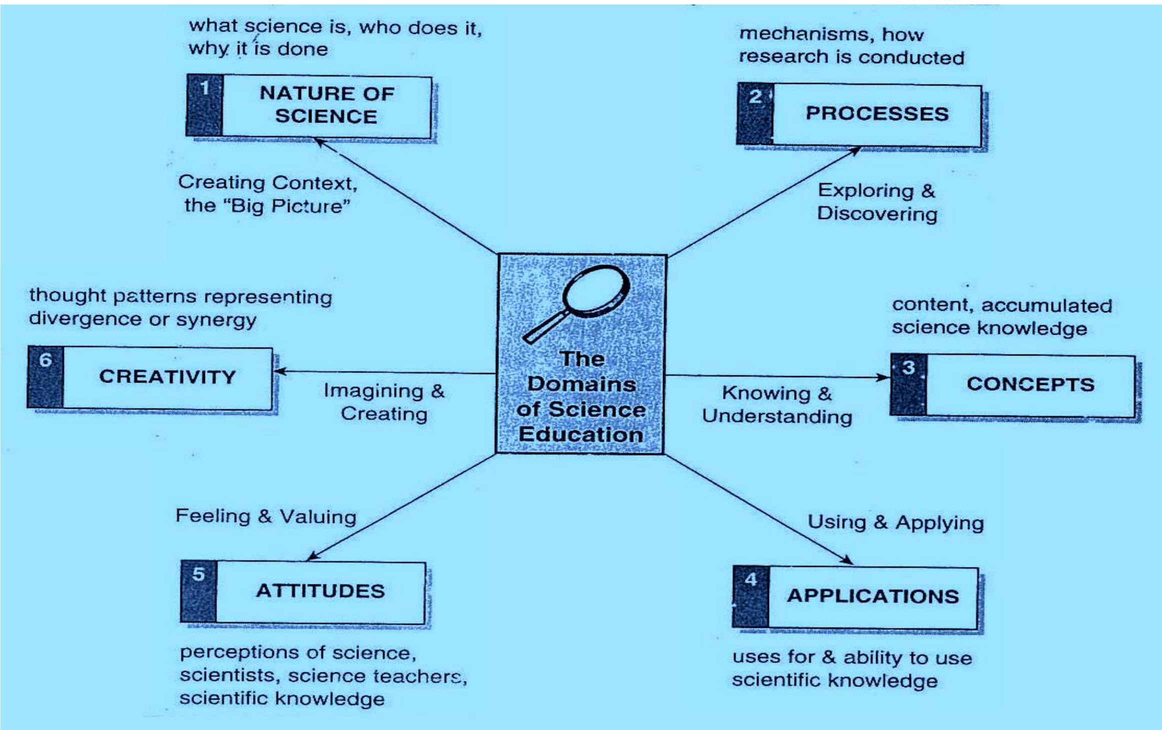
Science teaching should engage the learner in acquiring methods and processes that will nurture the curiosity and creativity particularly in relation to the environment. It should develop the ability to think logically and the ability for using scientific method of work. Overall there is a need to develop teaching style and strategy to ensure meaningful learning so that correct scientific concepts are developed and misconceptions are avoided.

1.6 Domains of Science Education

Science education is a discipline that provides students with the necessary foundation to allow them to conceptualize natural phenomena, and form connections between them (Unal & Ergin, 2006). It is not easy to describe what components exactly constitute the domain of science education because the nature, structure and functions of science have been described in different forms by philosophers, scientists and theologians. Science is a dynamic, expanding body of knowledge covering ever new domains of experience. Science curriculum in school covers following domains such as cognitive, affective and psychomotor. All the three domains develop students' higher order thinking skills.

Teacher should not focus only on cognitive domain, it is important that teaching of science should develop other domains of science such as affective and psychomotor. All the domains of science should not be learnt in a fragmented manner rather it should be learnt through integrated way. The method of teaching science and science learning should develop knowledge and skills, and attitudes which come under the different domains of science. Enger and Yager (2001) stated that learning science promotes scientific literacy. Enger & Yager (1998) also described six basic domains of science which can be best depicted through figure-1.2

Fig. 1.1: Basic Domain of science Education



Source: Enger & Yager (1998) (as cited in Bentley et al., 2007)

(I) **The Concept Domain:** it includes facts, laws or principles, theories and the internalised knowledge held by students fall under the umbrella of concept domain **(Yager and McCormack, 1989).**

(II) **The Process Domain:** it includes the thirteen processes identified by the **AAAS (1968)** in the development of science. A process approach is generally accepted sets of processes that scientists use as they accomplish their work.

(III) **The Application Domain:** it is the extent to which student can transfer and effectively apply what they have seemingly learnt in a new situation, especially one in their own daily lives **(Gronlund, 1998).** It is important because students use concepts and processes.

(IV) The Attitude Domain: it includes development of positive attitude towards oneself and development of more positive attitude towards science. In general. **Gardner (1975)** explained two distinguishable general categories of attitude (i) attitude towards science (ii) i.e., interest in science, attitude towards scientists, attitude towards responsibility in science) and (ii) scientific attitude (i.e., open mindedness, honesty or scepticism).

(V) The Creativity Domain: creativity is integral to science and scientific process. Creativity provides divergent thinking, alternative view point, novelty, puzzles and problems solving skills. Creativity plays an important role in many of the processes of science and in doing science.

(VI) The Nature of Science Domain: the nature of science is about how these ideas are developed through particular ways of observation, experimentation and inferences.

Science is the accumulated facts gathered by scientists as an outgrowth of their studies of nature which has resulted in a large body of verified knowledge. This knowledge has been organised into subject matter fields, such as Biology, Geology, Physics and Chemistry etc, in the form of product of science. Science is fundamentally a means of understanding why and how things happen in nature. It is a body of knowledge which includes facts, concepts, laws, principles, theories, hypotheses, generalizations etc. Science as a process include observations, scientific enquiry, asking questions, drawing inferences from evidences, recording observations, developing ways and means to find answers , classification and checking answers. It involves process of measurements, experimentations, classifications, and verifications, enjoying the evolution of thesis-antithesis and emerging as synthesis. Thus science is more than a subject; it is basically a method of acquiring knowledge, generating new knowledge and verifying existing knowledge in light with recent observations or knowledge.

1.7 Understanding of Scientific Concepts

A concept is a category used to group similar events, ideas, objects or people. Concepts are abstractions. They do not exist in real world. Only individual examples of concepts exist. Concepts help us to organise vast amounts of information into manageable units. Concepts are the building blocks of knowledge. They allow people to organize and categorize information. Everyone has a set of knowledge that can be acquired through beliefs, conceptions, understandings and experiences. They are a part of the models and theories we hold to make sense of the world around us. During early childhood, children actively engage in acquiring fundamental concepts and in learning fundamental process skills. Young children begin to construct many scientific concepts during the pre-primary period. Concepts used in science grow and develop as early as infancy. Babies explore the world with their senses. They look, touch, smell, hear, and taste. They also develop the processes that enable them to apply their newly acquired concepts, expand existing concepts, and develop new ones. As they enter the primary period, children apply their early, basic concepts when exploring more abstract inquiries and concepts in science. Thus when students come to school they already had some established knowledge about the physical, biological, and social world based upon their own ideas and explanations that may or may not be correct. If the wrong concepts of children are not corrected by school they tend to develop misconceptions in later stages (Charlesworth, 1995).

Thus, science concepts are central to science instruction, and student understanding of these concepts is crucial to successful teaching and learning. Miller (1989) noted that without concepts, it would be nearly impossible for students to follow much of the public discussion of scientific results or public policy issues pertaining to science and technology. According to Thagard (2009), conceptual systems are primarily structured via kind or is a hierarchies (i.e., Tweety is a canary, which is a kind of bird, which is a kind of animal, which is a kind of thing) and part-whole hierarchies (i.e., a toe is part of a foot, which is part of a leg, which is part of a body). If a basic goal of science education is to help students construct an understanding of the natural world, then students' prior knowledge should be the starting point for instruction. Students should have concrete experience with concepts before moving to abstractions, and they need opportunities to try and to do, not just read about science. The evidence that science concepts have been learned is evidenced most strongly when students can use concepts in a real- life or real-world situation (National Science Teachers Association [NSTA], 1982). Science in the classroom has been viewed and practiced for decades as a body of knowledge or facts to be learned or absorbed by students. Classically, this occurs by memorization of facts and concepts from a textbook. Knowledge and facts of science are clearly important and indeed necessary, but to memorize these facts as a sole purpose of science education violates the spirit of the very nature of science itself.

The Concept Domain of science includes facts, laws or principles, theories, and the internalized knowledge held by students (Yager & McCormack, 1989). These are the currently accepted scientific constructs related to all of the sciences, and students may best learn these concepts through a curriculum that is conceptually sequenced for developing student understanding. Students must also experience the curriculum from conceptually sound models of assessment and instruction. Science learning should promote conceptual linkages instead of a concepts-in-isolation approach. Concept mastery is an essential aim, but only when a meaningful context has been established. Both Benchmarks for Science Literacy (AAAS, 1993) and the National Science Education Standards (NRC, 1996) provide recommendations about content, concept and contexts.

Children are born with a tendency to organize their thinking processes into psychological structures. These psychological structures are our systems for understanding and interacting with the world. Piaget called these basic building blocks as schemes which help the children to mentally represent or think about the object in their own world. In addition to the tendency to organise their psychological structures, children also have the tendency to adapt to their environment. Adaptation to the environment takes place through assimilation and accommodation. Assimilation involves trying to understand something new by fitting it into what we already know. For example most of the children when see spider for the first time they think it to be an insect because spiders are small and children had made a schema that all small creatures are insects. Similarly children have scheme for birds like all those animals which fly should be accommodated in the scheme of birds. Accommodation occurs when a person must change existing schemes to respond to new situation. If data cannot be made to fit any existing schemes, then more appropriate structures must be developed. We adjust our thinking to fit the new information, instead of adjusting the information to fit our thinking. Children demonstrate accommodation when they add the scheme of recognising spider to their other systems of identifying animals. In this way scientific concepts develop in children through assimilation and accommodation which Piaget called equilibration (the act of balancing the concepts).

Enger and Yager (2001) opined that central focus of science instruction is to understand concepts. Concepts are always tentative; all propositions are subject to being revised or falsifiable. Hurd (1971) opined that significance of concepts and facts are constantly shifting within the scientific discipline and new ideas and theories leads to change the present knowledge. 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. Students should not come out of science class with a memorised set of definitions without understanding the contents. Students must know the reason behind the concepts why warm air rises up, why liquid evaporates, what is essential to support combustion, how sound travels in a medium. Practical learning should be promoted and rote learning should be discouraged. Such learning thus becomes more permanent, meaningful and concrete. The purpose of learning science at early stage is not to behave like scientists; rather the purpose is to develop concepts, process skills and attitudes towards science which will enable them to cope up effectively for their further education.

1.8 Meaning and Definition of Misconception

Concepts can be defined as ideas, objects or events that help individual understand the world around them. Conversely, misconceptions can be described as ideas, objects or events that are not in agreement with our own current understanding of natural science (Barke, 2012). Therefore, a misconception on the other hand can be defined as learning a concept in such a way that does not correspond to currently hold scientific theory (Skelly, 1993).The term "misconception" has many definitions. Wandersee (1985) defined a misconception as a concept often used to describe an unaccepted (though not necessarily "incorrect") interpretation of a concept by the learner. Fowler and Jaoude (1987) defined misconception "as an inaccurate understanding of a concept, the misuse of a concept name, the incorrect classification of concept examples, confusion between differing concepts, improper hierarchical relationships, or over- or under-generalizing of concepts". Students' incorrect patterns of responses, informal ideas, non-scientific interpretations and conceptions leading to conflict with scientific views are referred to by different terms such as "preconceptions", "misconceptions", "alternative framework" or "alternative conceptions" (cited in Karpudewan, etal, 2017). Misconception refers to any conceptual idea whose meaning deviates from the one commonly accepted by scientific consensus (Haslam & Treagust, 1987). Misconceptions are stable cognitive structures that affect learners' understanding of scientific concepts and these are highly restricted to change (cited in Karpudewan, etal, 2017). Mc Closkey (1983) defines misconception as a belief or an idea that is not based on correct understanding or correct information. Carey (1985) opines misconception as a wrong belief or wrong opinion as a result of improper understanding of facts. According to Guest (2003), when children hold views that differ from conventional scientific explanations or classifications they are often referred to as misconceptions. The term misconception also refers to the inappropriate understanding of any idea or concept (Peckmez, 2010). Mayer (2011) opines misconception is a conclusion that is wrong because it is based on faulty thinking or facts that are wrong. A number of term such as misunderstanding, misapprehension, mistake, error, misinterpretation, misbelieve are synonymously used for misconception (Read, 2004). For the present study, the definition given 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. Thus, misconceptions among students can be in the form of misunderstanding, mistake, error, improper/partial understanding of facts and concepts.

1.9 How Misconceptions are Created in Children?

Children's ability to process information, their thinking ability, develops slowly with experience and interaction and the information processing capability of a particular child will set limits on the complexity of concepts that the child can cope with. We have operations in the workings of our minds, or ways of thinking, which enable us to construct knowledge. This development is not just a matter of becoming faster or more accumulation of knowledge: there are qualitative changes in the way that children process new information as they develop cognitively.

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.

According to Von Glasersfied (1982) (as cited in Bodner, 1986), the learners construct understanding of concepts on their own. They do not simply mirror and reflect what they are told or what they read. Learners look for meaning and will try to find regularity and order in the events of the world even in the absence of full or complete information. This can be summarized in a single statement: Knowledge is constructed in the mind of the learner (Bodner, 1986). Constructivist theory views knowledge acquisition as the result of the life-long construction of both formal and informal knowledge. Informal knowledge is gained from interaction with the environment, whereas formal knowledge is gained through the intervention of the school (Bodner, 1986; Pine & West, 1986). Children construct knowledge in order to manage their experiences. An informal knowledge is constructed through interactions with parents, friends, and other influences. This knowledge base is built on everyday-life experience, influencing consideration of any or all explanations by children. Thus, it impacts whatever children will learn subsequently (Bodner, 1986; Butts & Brown, 1989; Driver & Oldham, 1986; Garnett & Stavy, 1992). If what children consider to be reasonable explanations are incorrect, and are provided with this knowledge (either formally or informally) via any media or school system, the incorrect knowledge will be maintained and this led to the creation of misconceptions among students. However, if they are provided with correct knowledge, that is, knowledge approved by consensus opinion, for example, respected scientists, learned teachers etc., and they are engaged in constructing meaning, the children may change their existing knowledge base (Cho, 1988; Inhelder & Piaget, 1958). Thus, Constructivist theory helps to provide explanations why children bring misconceptions to the classroom. Constructivists' perspective holds that misconceptions are incorporated into student cognitive structures.

1.10 Misconceptions in Science

The assessment of students' understanding of scientific concepts has been of interest to researchers and teachers in science education community recently. Various terminologies have evolved to describe students' understandings, which are different from or inconsistent within the consensus of the scientific community. Misconception is one of the various terms used by science education researchers to describe wrong knowledge (Brumby, 1984, Cho, 1988, Driver and Oldham, 1986, Doran, 1972, Fischer, 1985, Garnett and Stavy, 1992, Griffiths & Preston, 1992, Rayla & Rayla, 1938, Treagust, 1988). Others include misunderstanding (Marek, 1986) alternative framework (Betkouski, 1987) and alternative conception (Abimbola, 1988) preconceptions (Driver and Oldham, 1986, Novak, 1980, Tippet, 2010), and children's science (Gilbert, Osborne and Fensham, 1982). NCF (2005) also uses the term "alternative conceptions" or "misunderstanding" to describe improper or partial understanding of scientific concepts by students. In the present study, the term "misconception" is used because of its frequent appearance in research studies. Researchers have given various definitions to describe misconceptions in science. The term misconceptions refer to the students conceptions in different domains of science which are incongruent to the standard conceptions accepted by scientists (Clement, 1982). Duit (1987) stated that "misconceptions are conceptions which are incorrect viewed from the standpoint of 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.

Duit and Treagust (1995) suggest that "at all ages students hold conceptions about many phenomenon and concepts before they are presented in the science class. These concepts stem from and are very deeply rooted in daily experiences because they have proved to be helpful and valuable in daily life". These conceptions that students hold are sometimes grounded in scientific truth and other times are conceived through intuitive yet incorrect assumptions. Children develop ideas about natural phenomenon before they are taught science in school. In some instances these ideas are in keeping with the science which is taught. In many cases, however, there are significant differences between children's notions and school science. For example, a child who believes that the seasons are caused by the distance of the Earth from the Sun during its annual revolution is operating with a misconception. However the correct concept is that the seasons are caused by how Earth is tilted on its axis relative to the Sun.

Misconceptions are a problem for two reasons. First, they interfere with learning when students use them to interpret new experiences. Second, students are emotionally and intellectually attached to their misconceptions, because they have actively constructed them. Hence, students give up their misconceptions, which can have such a harmful effect on learning, only with great reluctance. (Mestre, 1999).

1.11 Causes of Misconceptions in Science

Some of the researchers such as Elizabeth (1988), Wadih (1993), Kathleen (1994), Quick (2003), Beer (2010), Cepeda (2010), Lemma (2013) had given the probable causes of the misconceptions among children. These causes are as follows:

- **Language:**

Language creates a lot of misconceptions in children. For example students are always taught that the sun rises in the morning and sets in evening, but in reality the sun never rises nor sets. It is static, the earth moves around the sun which causes day and night and thus we say that the sun rises in the morning and sets in the evening. Another example is, sun is like fire or river is flowing. It has been found that many small children have difficulty to differentiate between living and non-living things because of improper use of language. In our day to day life we speak or treat non-living things as living. In most of the books it is written that molecules expand on heating. This creates misconception among students that the molecules themselves expand when heated but the real concept is that the molecules themselves do not expand. The substance heated may appear to expand because heat causes molecules to move faster and further apart. Public Report on Basic Education, PROBE (1998) says that the language used in textbooks is criminally insensitive to children and violates their natural form of expression and comprehension. The tendency to 'package' as much information in as few sentences as possible, and to target children with encapsulated 'bullets', is an overarching trend in curriculum development and textbook preparation.

- **Lack of Availability of Science Laboratory and Teaching Learning Materials Related to Scientific Concepts:**

It was found in PROBE Report (2006) that physical infrastructure is far from sufficient in schools, number of teachers is not adequate and low level of teaching-learning activity was observed during the survey. Indian Institute of Science, Bangalore and National Knowledge Commission (NKC, 2008) stated that teaching science through experiments is largely missing in most of the schools. In many schools laboratory is not available, even where the laboratory is available, they are not upgraded. The students suffer due to lack of scientific materials, laboratory equipments deteriorate due to lack of maintenance etc. India Science Report (2004) (as cited in Ramesh, 2014) pointed that student's learning of science is low because of lack of scientific equipments, inadequate infrastructure.

- **Lack of Connection Between Abstract Concepts to Real Life Situations or Personal Experience**:

According to NCF 2023, it has been observed that often there is a lack of connection between students' everyday experiences/observations and the concepts presented in the textbooks or taught in the classroom. For example if we take the basic concept of evaporation, which is an abstract concept as the children do not see evaporation taking place so, rather than connecting the concept of evaporation through their day to day life (for example drying of clothes, drying of spilled water on floor etc) evaporation is introduced to children through water cycle which is again an abstract concept. As a result lots of student develop the misconception that water cycle and evaporation is synonymous and sunlight is necessary for evaporation. Similar type of misconception exists in students regarding photosynthesis and respiration, atoms and molecules, osmosis and diffusion etc.

- **Misconceptions of Teachers get Percolated in Students**:

Quick (2003), Lemma (2013) Yiebekal (2014) are of the view that if teachers had misconceptions regarding any of the scientific concepts then they transact the same misconception to their learners. Lederman & Lederman (2014) in their study found that teachers had a lot of misconceptions regarding even the simple concepts of science. They did not even have an accurate understanding of the differences and similarities between scientific enquiry and science practices. India Science Report (2004) pointed that student's learning of science is low because of lack of good teachers teaching science. Sanders (1993) and Yip (1998) have found that teachers had played a role in the formation of misconceptions held by their students. These studies indicated that misconceptions passed from teachers through wrong or inaccurate teaching. Furthermore, Sanders (1993) suggested that, assessment strategies used by Biology teachers could be a factor influencing the development of misconceptions in their students. She further says "teachers should not only assess to get marks for their pupils. They need to listen to what their pupil tell them, as it can provide information about pupil's understanding or lack thereof. Pupils require constant feedback about their correct and incorrect ideas".

❖ **Improper Instructional Process**:

Kathleen (1994) and Yiebekal (2014) are of the opinion that improper instructional process creates misconceptions among students. Science is more about doing rather than cramming but even today science is taught more through lecture method rather than through demonstration, Shelat (2013) also supported this view. Our teaching learning process does not promote naturalistic enquiry among children. Demonstrations used by teachers are often passive where students sit back and observe without manipulating materials or experiencing the phenomenon individually or in small groups. Khare (2009) found that some of the teachers were not even confident while doing demonstrations in their class. This can be one of the probable reasons why students were not allowed to manipulate the materials or experience the real phenomena individually or in small groups. Mehrotra (2006) also found that students mostly observe their teachers and their participation in classroom is very less. Mintzes et al., (2001) suggested several new instructional strategies that encourage meaningful learning and conceptual understanding in the biological science. Among these are teaching through the use of concept maps, V diagrams, portfolios etc.

❖ **Pictures and Diagrams:**

Pictures, diagrams, and 2-dimensional models in textbooks and other instructional materials can be misleading, and result in misconceptions. For example the diagrams of the water cycle in textbooks often show evaporation occurring over a large body of water, such as an ocean. The absence of other arrows indicating evaporation from living things, puddles, and the ground may lead to an incorrect conclusion about where evaporation occurs. In many science textbooks it has been show that the sun being much larger than other heavenly bodies in the solar system, but the planets and moons are incorrectly portrayed as being of similar sizes. Pupils therefore may correctly conclude that the sun is very large, though incorrectly think that the Earth and moon have comparable diameters (Allen, 2014).

❖ **Common Analogies:**

Some common analogies used to explain ideas can cause difficulty because the similarity is not complete. For example Earth is like an Orange. Sun is a ball of fire. Caterpillar is alive, when it becomes a pupa (chrysalis), it dies, and then when it appears as a butterfly it becomes alive again. Learners sometimes confuse the everyday meanings of words with scientific definitions. Colloquially, the 'animals' that young children tend to talk about the most are mammals commonly encountered on land, especially in the home or on farms, or played with as soft toys. They have fur/hair, walk on four legs and make their own peculiar noise. Anything else may not be considered as being an animal – this is especially the case with invertebrates such as jellyfish, snails, earthworms, crabs and insects. Vertebrates that fail to meet this furry/terrestrial/quadruped standard also may not be thought of as animals, e.g. fish, snakes and birds (Allen, 2014).

❖ **Abstract concepts:**

In a classroom, many of the students are in the concrete learning stage where it is really difficult for them to understand and comprehend those concepts which are asbract. The example of intermolecular space or empty space between atoms and molecules are abstract concepts because the students cannot see these spaces in reality and it is very difficult for those students who are in their concrete learning stage to understand those basic concepts. Another example is root absorb air from the soil. Students can't see air so, they have difficulty in understanding how air gets trapped between soil particles and how root absorb that air from those soil particles.

❖ Everyday Use of Terms:

Everyday use of certain terms, often used in non-scientific contexts, contributes to students' confusion and this confusion if not corrected leads to misconception. In English, certain words carry a wide range of meanings and associations and there are many "scientific word" which can more often be confused with a common use (e.g. heat rises rather the correct term is temperature increases). Some words have different conversational and scientific meanings which learners tend to find confusing. In an everyday context it would be acceptable to say that the submerged part of a floating object such as an iceberg has sunk because it has 'gone underwater'. However, during primary science lessons teachers need to make a clear dichotomous distinction when deciding whether an object is either floating or sinking it can never do both at the same time. In the case of the iceberg it is floating, because it is suspended in a fluid. In an everyday sense 'light' can be defined as any area that is illuminated, e.g. *we need some more light in here*, or *is it light outside yet?* As a consequence, pupils understand *"*light as being a general quality of a particular location which conflicts with the scientific idea of light as a form of energy that travels from one place to another". Furthermore, the word 'fish' is being added behind dolphin and seal in our daily life, which imply that they are fish rather than mammals. Bell (1985), in one of his studies, suggests that words 'energy' and 'food' are often used in everyday sense of being 'energetic' and needing 'to stay alive and 'be healthy'. Many word in biology are used in an alternative way in daily life, for this reason, some misconceptions may arise from the use of words that mean one thing in everyday life and another in a scientific context such as food, respiration and population. Gilbert et al., (1982), say "the word-particle- is scientifically used to mean atom, molecules or ion. However, in daily life it refers to small but visible piece of solid substance. Consequently this situation results in misapplication of that while explaining the air made up of small particles".

❖ Multimedia:

The media is the most powerful tool as it forms or develops the thinking approach of individual. The TV channels or the movies especially the sci-fi movies propagate false beliefs without much of scientific base in their content. The advertisement with fallacies and irrationality led to misconceptions among students. For example some kids cartoon character or the super hero posses extraordinary powers defying the concepts of time and space. When kids watch these superheroes they belief their powers to be true and real and they create some self concepts which are non-scientific.

- **Learners Themselves are Responsible for Perpetuating Misconceptions:**

Misconceptions may also originate from certain experiences that are commonly shared by many students. Some of them rooted in everyday experiences. The concepts like source of plant food, respiration in plants and classification belong to this category. Misconceptions also arise when students combine a newly learned concept (plants make their own food from soil). Such situation creates conceptual conflict in the students' mind.

- **Faulty Information from Science Textbooks:**

Occurrence of misconceptions in students is also caused by faulty information from science textbooks. Storey (1991, 1992) opined that science text books contain lot of erroneous and incorrect information. Many science concepts are interrelated and they are keys to understand other concepts. Therefore, not only lack of integration among topics but also inappropriate presentation of topics in textbooks influence students' further understanding. For example, Tekkaya (2002) opined that without understanding of photosynthesis, the concepts of food chain and food web are meaningless to students. However, before photosynthesis the students must understand the distinction between producers and consumers as well as organic and inorganic molecules. It should also be kept in mind of the textbook writers and curriculum developers that most of the concepts in biology are closely related to concepts present both in chemistry and physics. Berthelsen (1993), claimed that many biological concepts such as genetics , evolution, metabolic process, ecosystem, might have their foundation in physical science and students' understanding of biological processes breaks down because of physical science misconception. The researcher opined that "students understand that living things are made up of cells, but do not extend their understanding to include the concept that those cells are made up of atoms and molecules". Similarly the concept of conservation of energy is essential to understand many feeding relationships in food web, photosynthesis and respiration. However, students thought that energy was created and destroyed by living things rather than transferred in the various life processes. Therefore, it is reasonable to think that the lack of prior knowledge in chemistry and physics contributes to misconceptions in biology. Moreover, it is found that one concept of science is introduced in the textbook but other interrelated concepts which are essential to understand that concept is not at all introduced, so it leads to misconception of that particular concept.

1.12 Tools to Identify and Measure Misconceptions in Science

There are several tools which can be used to identify and measure misconceptions in science among students. Patil, et. al., (2019) has identified certain tools which can be employed to identify and measure misconceptions in science. These tools are as follows:

(A) Two, Three and Four-Tiered Multiple Choice Science Misconception Test

Two, three four or sometimes five-tiered multiple choice science misconception test had been commonly used by researcher across the globe to identify and measure misconceptions in science among students. The first part or the first tier of the test consists of multiple choice content questions with a set of multiple choice responses. The second part or the second tier consists of a set of justifications for the chosen response to the question asked in the first part. Sometimes empty space is also provided to write an alternative response. The third part or third tier is used to ensure the students confidence about the answer. Similarly the researchers can add fourth tier and fifth tier as per the need and requirement of their study. For example Sopapun (1994) developed “Two-Tiered Multiple Choice Test to measure misconceptions in Physics among elementary school students in Thailand”. Sahin and Cepni (2011) developed a Two-Tiered Test to determine differentiation in conceptual structures related to floating-sinking, buoyancy and pressure concepts among eighth grade students from two different primary schools in Giresun. Haki (2005) developed a Three-Tiered Diagnostic Test to measure misconceptions related to simple electrical circuits among ninth grade students. Bayuni et. al., conducted a study on identification of misconception of primary school teacher education students in changes of matter using Five-Tiered Diagnostic Test.

(B) Conceptual Understanding Test

In conceptual understanding test students are asked question in a hierarchy to activate their misconceptions on the subject. Then students are shown their misconceptions and were explained how their comprehension of the concepts is wrong. Students are explained examples with scientific explanations of the subject and concepts so that the conceptual change could occur. At the outset students are administered misconception related to the subject and later they are scientifically elaborated why those misconceptions are wrong (Tekkaya, 2002). Kucukozer and Kocakulah (2007) had administered a conceptual understanding test to measure secondary school student's misconception about simple electric circuits.

(C) Word Association Test

Word association is one of the oldest methods in the investigation of cognitive structure and has been used by several researchers. A small group is allocated key words as a stimulus from the specific topic and asked to write as many related terms as possible in a prescribed time for each stimulus word. Students are asked to identify and understand prefix, suffix and base words and to associate those words to relate their meanings. For example metamorphosis –meta (large), morph (change), osis (process); photosynthesis-photo (light), synth (make), isis (process). Studies of Senemoglu (2001) and Shavelson (1976) gave strong base and supportive research evidence for the appreciation of word association test for the identification and measurement of misconceptions. Koomson and Fordjour (2018) had used word association test to identify misconceptions among senior high school students in Ghana on concepts related to evaporation and water cycle.

(D) Concept Inventories

A concept inventory is a multiple choice research level instrument design to test students' conceptual understanding. Based on the numbering of key concepts from the subject each question or item have one correct answer and a number of incorrect answers. The most common use of concept inventories is to diagnose the alternative conceptions. Abdelhaleem (2002) constructed a Force Concept Inventory Test (FCI) to measure misconceptions about the concept of Newtonian Physics. KlymKowsky and Gravin (2008) developed Biology Concept Inventory (BCI) to measure misconceptions related to molecular, cell and developmental biology. Radhakrishnan (2013) constructed an Astronomical Misconception Inventory (AMI) to measure astronomical misconceptions prevalent among high school students of Kerala. The inventory had 32 true and false items. Akhilesh (2014) constructed a Concept Attainment Inventory (CAI) to measure misconceptions in Physics among standard VIII student in Kerala. The inventory had 80 true and false items to measure misconceptions in selected concepts of Physics viz. Matter, solar system, density, velocity, mass gravity, work, energy, light, sound, electricity, magnetism, force and pressure.

(E) Online Diagnostic Testing

It is a simple test design to diagnose and measure misconceptions in science among students. It is based on the computer assisted diagnosis of the misconception. The pre fixed conceptual test gives an indication of where students have mislinkages, wrong strategies, or incorrect knowledge. In order to make the accessing, storing, transmitting and manipulation of information easier, this approach integrates telecommunications, computers and relevant enterprise software, storage, middleware and audio- visual system required to handle the topic. Neset (2001) had used a web based Physics software programme to measure students' achievement and misconceptions in force and motion concept. Demirci (2005) had also used web assisted programme to measure misconceptions related to force and motion.

However, some other researchers such as Fredette and Clement (1981) had used written questionnaire along with interview to measure misconceptions in science among students. Kesidou and Duit (1993) had used clinical interviews to measure misconceptions related to heat among class 10th students. Fuller (1994) used concept mapping as a possible tool to measure misconceptions about light among fifth graders. Both open ended and close ended questionnaire was used by many researchers such as James (1989), Temiz and Yavuz (2014), Secken Nilgun (2010), Deshmukh (2012, 2015) to identify and measure misconceptions in science among students. Mc Willaim (2002) examined misconceptions in the area of force and motion through structured interview templates whereas Osborne and Cosgrove (1993) and Tyson, et. al., (1999) conducted semi-structured interviews of students to measure their misconceptions. Cradak (2009) had used open-ended questionnaire, interviews and drawing methods to identify misconceptions about birds. Yiebekal (2014) has used a combination of tests such as interviews, questionnaires, classroom observations, document analysis and Two-Tiered Diagnostic Test to measure misconceptions among grade 10th students on topic related to photosynthesis and cellular respiration in plants. Koomson and Fordjour (2018) had used concept map to identify misconceptions among senior high school students on concepts related to evaporation and water cycle.

1.13 Some of the Common Misconceptions in Science

Some of the researchers such as Henriques (2000), Keeley (2008), Levenson (1994), Mondal &Charkraborty (2013), Allen (2014) and Karpudewan et. al., in their studies had identified some of the commonly prevalent misconceptions in science. A list of these commonly occurring misconceptions in different streams of science along with its correct concepts have been depicted through table 1.1.

Table_1.1 List of Some Misconceptions on Various Concepts of Science

Misconceptions	Proper Concepts
Biology	
1. Fire is living thing because it moves, breathes reproduces, grows, excretes and consumes.	Before we can classify something being alive it needs to be capable of performing all of the seven processes of life such as movement, respiration, sensitivity, growth, reproduction, excretion and nutrition. Fire appears to fulfil six of these characteristics, but since a fire cannot sense its surroundings it cannot be categorised as a living thing.
2. Seeds are non-living things.	Seeds are living things. Seeds contain an embryo that is capable of germinating to produce a new plant.
3. Eggs are non-living things.	Eggs are living things. Eggs contain an embryo that is capable of growing into young ones.
4. Organisms grow bigger when their cells grow bigger.	Organisms grow bigger when their cells go through cell division and multiply.
5. Bigger organisms have bigger cells.	Bigger organisms have more cells.
6. Bacteria have intestines and lungs.	Bacteria are micro organisms and it does not have intestines or lungs.

7.	**Microbes inside our body are alive while microbes in the environment are not.**	Whether microbes present inside or outside the body does not make difference in their status of living things.
8.	**Male animals are always bigger and stronger than females.**	That may generally be true for human beings, but it is not so for many animals, e.g. the queen ants and bees are much bigger than the males.
9.	**Animals are furry and have four legs.**	Organisms which can consume food and is capable of movement are animals. It is both unicellular and multi-cellular.
10.	**A bee is not an animal because it is an insect.**	All insects are animals.
11.	**Lizards and snakes are amphibians.**	Both are reptiles
12.	**A whale is a fish because it lives in sea.**	A whale is a mammal because it gives birth to young ones.
13.	**Insects have a pair of legs.**	Insects have three pair of legs.
14.	**Crabs are vertebrates.**	Crabs are invertebrates.
15.	**Snakes are invertebrates.**	Snakes are vertebrates.
16.	**Human beings are not animals.**	Human beings are also animals.
17.	**Heart purifies blood.**	Heart is a pumping organ which only pumps blood to different parts of the body. Blood is purified by kidneys.
18.	**The heart lies at the left side of the chest.**	The heart lies at the centre of the chest.
19.	**Our heart beats faster during exercise in order to work our muscles.**	During exercise, muscles work harder and so need a greater supply of oxygen. In response heart beats faster to speed up blood flow.
20.	**The blood in our veins is blue.**	The blood in our veins is deep red because of low level of oxygen.
21.	**Respiration is the same as breathing; the respiratory system is for carrying out respiration.**	Respiration is the release of energy from food and takes place in the cells, with or without oxygen. Breathing is the exchange of respiratory gases between the body and the surroundings through the respiratory system.
22.	**We breathe in only oxygen and we breathe out only carbon dioxide.**	We breathe in air and we breathe out air but the air which we breathe in contains more percentage of oxygen and the air we breathe out contains more percentage of carbon dioxide.
23.	**There are air tubes linking the lungs and the hearts.**	The lungs and the heart are linked by blood vessels.
24.	**Plants breathe in carbon dioxide and breathe out oxygen.**	Plants also breathe in oxygen and breathe out carbon dioxide.

25. Plants do not respire, or they only respire in the dark.	Plants respire all the time.
26. Respiration in plants occurs only in the cells of leaves, since only leaves have gas exchange pores.	Respiration takes place in all plant cells.
27. Plants carry photosynthesis during the day and respiration during night.	Plants carry respiration all the time but photosynthesis is carried out during the day because sunlight is necessary for the process of photosynthesis.
28. Photosynthesis is a plant process and respiration is an animal process.	Both plants and animals undergo the process of respiration.
29. Digestion starts in stomach.	Digestion starts in mouth where the salivary amylase (a digestive enzyme) acts on the starch in food.
30. The stomach is located around the naval area.	The stomach is usually sited at the level of the ribs on the left side of the body.
31. Our entire body is a hollow bag.	Our entire body is not a hollow bag.
32. The digestive system has two outlets one for faeces and one for urine.	The digestive system has one outlet, the anus through which undigested food is discharged from the body.
33. The only reason we eat food is it gives us energy.	Food is important for physiological purposes.
34. Wild animals never go short of food.	In food chain depending upon the predator and prey, wild animals can have food shortage.
35. Food only contains fat if the fat can be seen.	Fats are not always visible. Many seeds and nuts contain fat.
36. All fats are bad for us.	All fats are not bad. Some fats are good for health.
37. Roots are organs for feeding.	Roots absorb minerals and water for the plants. Minerals and water are not food for plants.
38. Fertilizers are plant food.	Fertilizers are not plant food. They supply minerals to the plants.
39. Plants get their food from soil.	Plants make their food by photosynthesis.
40. All plants are flowering.	There are many plants which do not have flowers.
41. Trees are not plants.	Trees are also plants.
42. Mints, Coriander etc. are not plants.	Mints, corianders are also plants. They are called as shrubs.
43. Chameleons change the colour to blend with their surroundings.	Chameleons change their colour from brown to green, red or even pink and orange according to their moods.
44. Bats are blind.	Bats are not blind. They have eyes. They are nocturnal animals and they use ultrasonic waves to locate objects in the darkness.
45. Camel store water in its hump &	The camel stores fat in its hump & it

the hump gets smaller as the camel uses up water.	grows smaller if the camel has not eaten for long time.
Chemistry	
46. Atoms are alive because they move.	Atoms vibrate because they all possess some thermal energy. They do not possess the characteristics of living things (i.e. needing energy to survive, producing wastes, reproduction, adaptability etc.) The nuclei of cells and atoms are not synonymous.
47. Atoms are like cells with membrane and nucleus.	
48. Atoms can reproduce after nuclei divide.	
49. Molecules of solids are hard, molecules of gases are soft.	Molecules shape, size and mass do not change between solid and gas phases. Just because the phase as a whole appears different, e.g. often the gas is less visible than when in the solid form, doesn't mean that the molecules themselves have changed. Only the forces of attraction between them changes. Changes of state are physical changes.
50. Molecules of solids are biggest, molecules of gases are smallest.	
51. Molecules of solids are cubes, molecules of gases are round.	
52. Vapour molecules weigh less than solid molecules (e.g. water vapour vs. ice)	
53. A material is something used for building, clothing and stationary.	In science, a material is something that is made of matter i.e atoms, molecules or ions.
54. Salt dissolves in water only in powdered form.	It is the characteristics of salt to dissolve in water whether in crystalline form or amorphous/powdered form
55. When things dissolve they disappear.	When water and a solid such as salt are mixed together all of the molecules of the solid are separated and break apart from each other by the water. The salt atoms then blend with the water molecules to form a solution.
56. Air and oxygen are the same thing	Air and oxygen are two separate things. Oxygen is a component of air. The air in our atmosphere is composed of molecules of different gases. The most common gases are nitrogen (78%), oxygen (about 21%), and other inert gases 1 %.

57. Water only gets evaporated from oceans, rivers and lakes.	Water can evaporate from plants, animals, puddles, and the ground in addition to bodies of water.
58. The water cycle involves freezing and melting of water.	The water cycle involves evaporation of liquid water, condensation of water vapour and precipitation (rain, hail or snow)
59. The water cycle includes only rain and snow.	Ice in all its forms (sea ice, glaciers, ice sheets, icebergs and permafrost) is part of the global water cycle.
60. Evaporation takes place only when there is sunlight.	Evaporation can take place without sunlight. Water molecules at the surface obtain energy from the surrounding water molecules to evaporate, leaving the remaining water cooler.
61. The bubbles seen in boiling water are air bubbles.	The bubbles are water in gaseous state.
62. Anything natural is not pollution.	There are many natural sources of pollution, e.g. volcanoes, bush fires, rotting vegetation which gives out methane gas.
63. Air has no weight or negative weight.	Air has weight and the weight of air per unit area is air pressure.
64. Air is one substance.	Air is made up of a mixture of gases.
65. Gases do not have mass or weight.	Gases are matter, and thus they have mass and weight.
66. When an object burns, part of it disappears and no longer exists.	During combustion mass of material is always conserved.
67. Candle wax does not burn, it just melts.	Burning a candle on a balance will show a slow and steady decrease in mass as the gaseous products of combustion escape. If the candle were merely **melting**, then the mass would remain the same.
68. All acids are corrosive.	All acids are not corrosive. In fact quite a few acids are common foodstuffs so are not corrosive or otherwise harmful.
69. When burning paper shrinks to leave ash, part of it has evaporated.	When burning paper shrinks to leave ash, part of it has not evaporated. It is simply an irreversible change
70. Rust is a type of decay caused by fungus.	When iron or steel is exposed to prolonged moist conditions it takes part in a chemical change. The iron combines with oxygen from the air and/or in the water to become brown/orange iron oxide, what we commonly call 'rust'. This is wholly a chemical change and does not require the action of any living organisms such as fungi or bacteria.

71. Particles in a liquid are further apart than particles in a solid.	The solid and liquid particles are equal distance away.
72. Flat tyre has contains no air.	To state that a containing vessel such as a tyre does not have any air inside implies that there is nothing at all present, i.e. a vacuum exists within the tyre, which scientifically is incorrect
73. When a party balloon is inflated with air, the balloon becomes lighter.	The inflated balloon is actually heavier than the deflated one. This is because the act of blowing up a balloon forces air in under pressure, which makes the air particles inside the balloon more concentrated than in the surrounding air.
74. When a solid dissolves in water it does not contribute to the mass of the solution.	When a solid dissolves in water the mass of the entire solution increases.
75. A solid is lighter when in powdered form.	A single grain of powder is made from exactly the same substance as a larger piece of material, so has the same density as that larger piece.
76. Ice is heavier than water.	When any material melts its mass is always conserved because, although there has been a change in state, the number of particles in both the solid and liquid forms is the same, assuming no experimental losses due to evaporation.
77. Boiling and evaporation are irreversible change.	State changes such as boiling are reversible then steam can be cooled and condensed to become liquid water again.
78. Liquids that evaporate or boil disappear forever.	Boiling is the state change that takes place when a liquid becomes a gas at its boiling point, which in the case of pure water is 100ºC at normal atmospheric pressure; the gas produced by boiling is steam. On the other hand, evaporation is when a liquid becomes a gas below the boiling point; the gas produced in this case is water vapour, which is gaseous water below 100ºC.
79. Clouds are made of gas.	Clouds are composed of water mainly in the liquid phase and not the gaseous phase. Examined microscopically, they would appear as water droplets suspended in the air.
80. A cola can get wet because liquids from the inside seep through to the outside.	Invisible water vapour in the gas phase is present in the air surrounding the drinks can, and when it comes into contact with the cold can the water vapour cools and condenses into water in the liquid phase.

Physics	
81. Heavy objects fall at a greater speed than the lighter objects.	If several objects of different mass are dropped simultaneously from the same height they will all hit the ground at exactly the same time, if air resistance effects can be negated.
82. Forces always act in pairs that is equal and opposite.	It is true that forces frequently act in opposing pairs on a system; however, these two opposing forces do not have to be equal in size.
83. At a steady speed there are no forces acting on a body.	In fact forces do apply but cancel each other out so the body is at a state of equilibrium.
84. An object at rest has no force acting upon it.	Weight is a widely known force that acts on a body upon rest.
85. Rotation is the same as revolution.	Rotation is the movement which involves turning about an axis, as in a spinning top. Revolution is the movement in an orbit, as in the Earth revolving round the Sun.
86. The moon gives off light.	The moon is a non-luminous body. It can be seen because it reflects the light from the Sun.
87. Mass and weight are the same thing	Weight and Mass are two different things. The force of gravity acting upon an object or person is referred to as the weight of the object or person. The mass of an object or person refers to the amount of matter that is contained by the person or object.
88. There is a loss in mass when ice changes to water.	There is no loss in mass when ice changes to water.
89. Shadows are always black.	A shadow is caused by an object blocking light so naturally it would appear to be black but translucent objects create colourful shadows.
90. An electric cell is called a battery.	A battery is made up of two or more electric cells connected in series.
91. Force and energy are synonymous.	Force and energy are different concepts. Force is a push or a pull while energy is the ability to do work.
92. Fuel is energy.	Fuel contains energy or fuel is a source of energy.
93. There is no gravity at the moon.	Gravitational attraction is experienced by every object in the universe
94. Gravity becomes stronger the	Gravity behaves according to a

further we are from ground.	mathematical relationship known as an *inverse square law*, meaning that if the distance that separates two objects is halved, then the gravitational strength is quadrupled. Another aspect of this relationship is that as distance is increased, gravity drops off very fast, so over long distances its effects are extremely weak.
95. All light objects float and all heavy objects sink in water.	A simple yet correct way to think about the question of whether something will float or not is to consider how its density compares with that of water.
96. An iceberg is floating and sinking at the same time.	In the case of the iceberg it is floating, because it is suspended in a fluid.
97. Wood is denser than water.	If the density values are examined, water (1.0) is significantly denser than common woods such as pine (0.4) and elm (0.6). Even comparatively heavy woods like teak (0.7) and mahogany (0.8) are less dense than water, and very light woods such as balsa (0.1) have a low density.
98. An object floating in water has less weight.	Every object is constantly being pulled towards the Earth by a pulling force called weight (or gravity)
99. Light is only found in bright areas.	Light is not only found in bright areas. For example if light is travelling from the torch bulb towards the flat surface, light can be said to exist in the area in between, in the form of a beam.
100. We see things because light travels from our eyes towards an object.	We see an object because the eye is able to absorb light rays travelling from the object
101. The moon is a source of light.	The moon is a very bright object when viewed in the night sky because it is reflecting light from the sun and directing some of it down towards the Earth.
102.My shadow is always there inside me and bright light can push it out.	Shadow is simply another facet of an object.
103.White light is pure. Coloured light is white light with impurities in it.	White light is a mixture of seven different coloured lights.
104.Sound cannot pass through obstacles.	Sound travels quite effectively through solids such as glass and wood, and this is the reason why we are able to hear sounds from outside while in a room with all the windows and doors sealed.
105.High sound is loud while low sound is quite.	When a sound is described in a scientific context as being high or low then this usually refers to its pitch.

106. Earth is a sphere and we live inside it.	We do not live inside Earth.
107.All metals are magnetic.	All metals are not magnetic
108.The Earth lies at the centre of the solar system, with the sun and the planets orbiting around it.	The Sun lies at the centre of the solar system, with the Earth and the planets orbiting around it.
109. Clouds are responsible for day and night.	The phenomena of day and night occur due to the fact that the Earth is spinning on its axis.
110.The Earth, Sun and Moon are of similar size.	The Earth, Sun and Moon are not of similar size.
111.The Moon orbits around the Sun.	The Moon orbits around the Earth and the Earth orbits around the Sun.
112.The Earth's shadow is responsible for different phases of moon.	The Earth's shadow is responsible for lunar eclipse.
113.The moon only appears at night.	The Moon orbits the Earth approximately every 28 days, its relative direction from Earth changes significantly every day. This means that on a particular date if the moon is seen to rise during the night-time, 14 days later it will be rising during the daytime.
114.Seasons are caused by the distance of Earth from the Sun.	Seasons are caused by how Earth is tilted on its axis relative to the Sun.
115.We have longer days in summer because the Sun moves more slowly across the sky.	Days are longer in summer and shorter in winter because the times that the sun rises and sets are constantly changing from day to day.

(Sources: Henriques, 2000; Keeley, 2008; Levenson, 1994; Mondal & Chakraborty, 2013, Allen, 2014* , Karpudewan, M., Narulazam, A., Zain, M. & Chandrasegaran, A. L., 2017*)

1.14 Rationale

If we throw a bridge between science and education, using psychology, we arrive at the concept of science education, which, bluntly speaking is an integrated concept. If so, it is then within the realm of possibility to link the most powerful concepts of science to the growing minds of children through active experimental pedagogy. Learning science should never only be about learning to know the natural world. Science education has to be recontextualised in order to be meaningful in school. Findings of Hoshangabad Science Teaching Project in Madhya Pradesh HSTP (1970-2002) a massive Science teaching programme revealed that "Science teaching is mainly textbook-based rote learning with little emphasis on understanding of concepts or the process of science, students are unfamiliar and far behind in basic process skill". In many classrooms today “teaching” means talking, and Learning means “listening”. HSTP is the pioneer in reconceptualising science teaching.

Science is being described as part of everyday life and an understanding and appreciation of science concepts and process is required by all members of society if they are to be active citizens making informed decisions and contributions to debate about relevant issues and events. Various committees from Secondary Education commission (1952-1953) to National Curriculum Framework (2005) have recommended for science to be taught through purposeful, concrete and realistic situations and also talked of improving the quality of science education. In order to strengthen the quality of science education at all levels there seems to be an urgent need to practice learner centered, activity based, competency dependent inquiry approach for teaching science, which will make learning of science an enjoyable experience for children others wise it may lead to misunderstandings and misconceptions.

Students learn the concept of knowledge about the world around them from an education system at schools or informal way according to their experiences, which are frequently used to construct an insight with the student perspectives. Because of that matter, some researches had been held to provide information about student understanding, especially in learning science concepts. Students entering the science classroom have a number of previous experiences, ideas, beliefs and expectations about the natural world. The content taught in the classroom should be interpreted in the light of this prior knowledge. Even after formal instructions, students’ spontaneous conceptions often remain at variance with accepted scientific ideas. These have been labelled as alternative conceptions, misconceptions, pre-conceptions or naive conceptions. On the basis of the literature reviewed it has been found that research all over the world has gone into uncovering misconceptions and drawing their implications for learning.

National Research Council (1997) stated that “the primary role of misconceptions in science is a barrier for students to learn science because in many cases, misconceptions can detain students to develop correct ideas used as the initial insight for advanced learning”. This is parallel with King (2010) who unveiled that “misinterpretations found in the textbook of Earth Science influence students’ understanding of a scientific text which makes them difficult to comprehend further information or knowledge as a reader”. According to Moodley & Gaigher, 2019 many a teachers themselves experiences misconceptions while teaching the concepts of physics, chemistry and biology which unknowingly gets transacted into their students. Therefore, it can be concluded that misconception can disrupt the effectiveness and productivity of the science learning experiences, impacting both students and teachers in terms of the process and results.

Students' misconception and misunderstandings is a major threat in general teaching-learning process at school level. Misconceptions cover a large range of science concepts, so science educators in many countries are paying attention upon students' misconceptions about scientific concepts (Osbome and Wittrock, 1983). Many students have difficulty in learning science because much of their learning tends to involve memorization of facts in which newly learned materials is not related in ways that make sense to the learner (Novak, 1988). However, learning in science is not just adding new concepts to the knowledge, but it often requires realignment in thinking and construction of new ideas that may be in conflict with earlier ideas. Additionally, research studies have consistently shown that students do not come to classroom with blank slates (Posner, et.al., 1982). In fact, students from the moment of birth need to make sense of their world. They construct their own understanding for how and why things behave as they do. So, long before they begin formal schooling, children have made meaning of their everyday observations and, they will construct new knowledge on their previous experience. As accepted by many scientists, when these students' previous conceptions are different from the views of scientists, these differing frameworks affect further learning negatively. In order to remove students' misconceptions, it is necessary to identify the sources of these misconceptions. During learning, the students try to connect new knowledge into his/her cognitive structure. If they hold misconceptions, these misconceptions interfere with subsequent learning. Therefore, new knowledge cannot be connected to their existing structure and misunderstanding of the concepts arises (Nakhleh, 1992). Misconceptions are a serious problem because it prevents learning and creating obstacles to further learning (Canpolat, 2006, Pabuccu & Gibbon, 2006).

The researcher had carried the present study on eighth standard (upper primary stage) students in Ranchi district of Jharkhand State. The eight-year span from grades I to VIII represents a crucial phase of substantial cognitive growth, molding reasoning abilities, intellect, social skills, and preparing individuals with the essential skills and attitudes needed for entering the workforce. According to NCF (2005), at the upper primary stage the children are getting their first exposure to science as separate subjects. It is a crucial stage wherein students are expected to learn more scientific concepts correctly. Also eighth standard is the threshold of secondary education and it is also a transition phase between primary and secondary level. In this stage the students should develop a lot of clarity about basic concepts of science. Beard (2007) suggests that science should be taught through experiential learning method such as activity based learning, demonstrations, experiments or through scientific enquiry but (Malhotra, 1998, Umasree, 1999, Ramkumar, 2003 and Shelat 2013) found that lecture method is being commonly used in our classrooms and our students did not get hands on experience. As a result when our students did not understand any of the basic concepts rather than explaining them through experiments or connecting those concepts to their day to day life, the teacher teach the same concepts twice and thrice through lecture method. Because of this the correct concept formation in students does not takes place. As we know that in science most of the concepts are inter-related and if one concept is not understood properly it may lead to improper understanding of other related concepts. It has proved through some researches (Alvermann et al., 1985, Diakidoy & Kendeou, 2001, Maria & MacGinitie, 1987, Diakidoy,Vosniadou, & Hawks, 1997, Nussbaum & Novak, 1976, Vosniadou & Brewer, 1992, 1994) that if children do not have clear concepts about scientific principles and process they tend to develop misconceptions and one misconception leads to another which sometimes persist throughout their lives.

It is fairly well recognised now that misconceptions cannot be easily replaced by correct scientific ideas. One way of looking at this resistance is to imagine students' conceptions from an interconnected system of beliefs: about the nature of science, of school, of learning and of the world around. Any one of these beliefs cannot simply be treated as a scientifically inaccurate idea that is easily corrected. The idea has to be understood in terms of a more general world-view held by the student, and it has to be also tackled from that perspective (Ramadas, 1993). Knowledge is constructed through interaction with the physical as well as the social environment. Misconceptions, therefore, need to be seen in terms of the context of learning, including the socio-cultural and linguistic background of students and its relation to the classroom climate

Therefore, it is of utmost importance that the misconceptions among students must be identified then only proper teaching learning strategies can be developed to minimise it.

Hence the researcher has decided to conduct a study on misconceptions in science with the following research questions.

1.14.1. Research Questions

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

1.14.2. Statement of the Problem

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

1.14.3. 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

1.14.4. 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 higher educational level and lower educational level of teachers on misconceptions in science among students of standard VIII.
5. There will be no significance difference higher professional level and lower professional level 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 levels and lower educational levels of parents on misconceptions in science among students of standard VIII.

1.14.5 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.

1.14.6. Operationalization of the Term

1. Misconception 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. 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 be used to know the probable causes of misconceptions and third tier was used to know the probable sources of misconceptions.

1.14.7. 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.

This chapter presented the conceptual clarity on misconceptions in science. Also rationale, objectives, hypotheses, explanation of the term, operationalization of the term and delimitation of the study were included. The subsequent chapter would depict the scenario of research studies in the area of misconceptions in science in India and abroad.