CHAPTER 2.

REVIEW OF RELATED LITERATURE

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In the first chapter researcher discussed about the Introduction and conceptualization of the problem, its background, statement and significance of the problem, objectives and research questions formulated delimitations and operational definitions of the study. Current chapter focuses on the past studies done the field of alternative conceptions or misconceptions.

2.1. Introduction

There have been a lot of studies done in the field of misconceptions and alternative conceptions. More focus here has been given to the topic misconceptions/ alternative conceptions in science and they are studied as physical science comprising of misconceptions/alternative conceptions in the field of maths, physics and chemistry and biological science comprising of misconceptions/alternative conceptions in the field of biology. Following are some of the studies done in the field of misconception/ alternative conception.

2.2. Alternative Conceptions / Misconceptions

The term misconception and alternative conceptions are often used synonymously; however, there is a basic difference in the semantics of the two. The word *misconception* starts with 'mis' prefix which depicts error or wrong notion of a thing or phenomenon whereas the word *alternative conception,* gives an idea of 'different' or 'other' perspective of thing or phenomenon. Hence some researchers and educationists state that a learner's conception should not be treated as misconception if it does not match with the previously accepted concepts in that particular field, because every conception in the mind of learner is based on prior knowledge, daily life activities and experiences. (Fujii, 2014)

In article, 'Mistakes, Alternative Conceptions and Prior Knowledge', it is stated that alternative conception allows learner to explain concepts in their own way, which can be treated as the starting steps to lead towards more productive thinking.

Taber (2014), used the word alternative conception with many synonyms such as misconceptions, preconceptions, alternative frameworks, alternative conceptual frameworks, intuitive theories, and mini-theories. He defined them as ideas relating to science topic which are odd with the target knowledge set out in the curriculum. In 1980s, the interest in students ideas came to prominence in science education through a considerable research programme also called as 'Alternative Conceptions Movement' developed around eliciting such ideas.

Thompson and Logue (2006) did a study on miscoception on the basis of an assignment for a teacher-training course. The objectives of the study were to define three scientific concepts and identify for each some of the misconceptions that students commonly haveit was found that the level of misconceptions varied between concepts. There appeared to be some patterns in the level and type of misconceptions between the three age groups, suggesting that a more rigorous study in this area would be of value.

2.3. Misconceptions in Physical Science

Misconceptions in physical science are comparatively more in number than that in biological science, due to more abstract concepts in the subjects like physics, chemistry and maths. Following are some of the research works done in misconceptions in physical science.

Singh (2007), examined the effect of misconceptions about friction on students' ability to solve problems and transfer from one context to another. It was found that misconceptions associated with friction in problems were sometimes so strong that pairing them with isomorphic problems not involving friction did not help students fully discern their underlying similarities.

Paul (2018), in his study stated that physics is a subject that can be taught with the help of various examples, activities and experiments connected with life situations. He tried to identify the difficulties and misconceptions in learning the unit Semiconductor Devices and their Applications. A sample of 360 students from 9 different schools distributed in three districts was selected for the study. The tools used by the investigator were personal interview schedule, personal data questionnaire and the Diagnostic Test. The Diagnostic Test was constructed with 122 multiple choice questions and 26 short answer questions in the unit Semiconductor Devices and their Applications. The Tools were administered to the sample of 360 students and the data were collected. The collected data were analysed and interpreted using statistical devices like, F-test, t-test and Pearson's Correlation.

Sen & Chouhan (2019) did an action research on student teachers of RIE Bhopal. Study concerned about the misconceptions in secondary science. They suggested to physical sciences student teachers that rather than teaching physical science theoretically, practical approach with enquiry-based mode, through verification of laws, theories and rules of natural sciences will provide more concrete and depth understanding of the concepts.

Ozmen, (2004) says that students' misconceptions before or after formal instruction have become a major concern among researchers in science education because they influence how students learn new scientific knowledge, play an essential role in subsequent learning and become a hindrance in acquiring the correct body of knowledge. In his paper, some students' misconceptions on chemical bonding reported in the literature were investigated and presented. The study is based on literature review of chemical bonding.

Burgoon, Heddle, & Duran, (2011) stated that there has been less work on misconceptions among teachers as compared to work done on the miscoceions of

students, whereas it is seen that both teachers nd students possess similar misconceptions. The study explored the physical science conceptions of 103 elementary science teachers to determine whether, after three decades of misconception research, teachers still possess conceptions similar to those held by students. They found that teachers expressed misconceptions regarding gravity, magnetism, gases, and temperature that were similar to common student misconceptions.

2.4. Misconceptions in Biological Science

As the standard of students upgareds in schools every year, the concepts in currriculum starts becoming more amd more abstract in nature. Likewise in earlier classes conceptsof biology are very concrete but as students move to upper grades, abstract knowledge of concepts photosynthesis, respiratio, reproduction, cell biology, etc is included in the syllabus. Some students in order to explain certain phenomenon, try to construct their own understanding based on prior knowledge and experience, occasionally leading to misconceptions or alternative conceptions. Following are some of the research studies done in the field of misconception in biology.

Svandova (2014) investigated the common misconceptions of lower secondary school students regarding the concepts of photosynthesis and plant respiration. These are abstract concepts which are difficult to comprehend for adults let alone for lower secondary school students. Research of the students misconceptions are conducted worldwide. The researches show that many students do not even understand the fundamental concept that photosynthesis and plant respiration are related, mutually connected physiological functions. Many mistaken photosynthesis for plant respiration and that respiration took place only in leaves where are special organs such as pores. They also believed that the plant produced oxygen over the entire day and that the most important source of food for plants is water with dissolved mineral substances. In the

study, researchers propose teachers that teachers could eliminate misconceptions by graphic explanation of these concepts, correct chemical clarification of photosynthesis and respiration, and connecting integration about this processes. The data was analyzed in several ways first by the students' knowledge (correct/incorrect answers), then by their misconceptions (frequency of occurrence of misconceptions).

Yip (1998) probes Certificate-level students' (age 17+) understanding of the menstrual cycle by analyzing their performance on a multiple-choice item in a public examination. Many students showed problems in relating the time of conception to the condition of the uterine lining. By reviewing the possible causes of misunderstanding, it was suggested that conceptual development can be promoted by classroom instruction that avoids excessive factual detail, establishes meaningful connections between new and existing concepts, and takes into account students' prior knowledge.

Queloz, Klymkowsky, Stern, Hafen, & Koehler (2017) constructed concept inventories, based on an analysis of students' thinking and their explanations of scientific situations, serve as diagnostics for identifying misconceptions and logical inconsistencies and provide data that can help direct curricular reforms. they distributed the Biological Concepts Instrument (BCI) to 17-18-year-old students attending the highest track of the Swiss school system (Gymnasium). It was found that students' performances on many questions related to evolution, genetics, molecular properties and functions were diverse. Important common misunderstandings were identified in the areas of evolutionary processes, molecular properties and an appreciation of stochastic processes in biological systems. Observations provide further evidence that the BCI is efficient in identifying specific areas where targeted instruction is required.

Raharjo, Ramli, & Rinanto (2019) conducted research to construct and develop the specific diagnostic test to detect the misconception in protest material. The

instrument consisted of, Evidence and Proof (EP)[1], Structure Communication Grid (SCG)[2], and essay. In general, the instruments constructed by researchers here can be accepted and used after revisions. These diagnostic test instruments can also be developed for another topic.

(Kwen, 2005) in his study showed misconceptions among pupils are resistant to change, and that they persist even with formal science instruction. The paper highlights teachers' (or question setters') misconceptions concerning some key biology science concepts in the areas of plant and animal morphology, function and genetics. It is based on a scrutiny of numerous sets of primary science examination papers in Singapore Schools (first and second semestral assessment science papers, ie SA1 and SA2) in three different contexts:

1) Setting school examination papers with a view to helping schools improve the quality of their examination questions;

2) Conducting school-based workshops on how to craft better examination questions;

3) Conducting National Institute of Education in-service courses for primary school teachers.

Mak, Yip, & Man (1999) reported a study of the alternative conceptions held by junior secondary science teachers enrolled in an in-service teacher training program. The subjects completed a written instrument which probed their understanding of biological concepts in the integrated science curriculum. The subjects, particularly the non-biology graduates, were found to show serious misunderstanding in concepts

[1] This test instrument was developed in a form containing a series of conceptual questions about protists . This question is divided into two components. The first component is in the form of brief statements, and students are asked to identify the truth of the statement by giving a mark in the column provided. The answer must be confirmed by data or facts that support the answer. The second component is a follow-up of the first component, and students are asked to provide arguments and logical reasons for their answers.

[2] The SCG test is developed in a form that contains structured statements related to a phenomenon (Figure 2). The instruments are arranged in two interrelated components. The first component is nine statements in nine boxes arranged randomly. Students are asked to choose six correct statements related to the phenomenon and make the right sequence. In the next component, students are asked to provide logical reasons for their answers based on data and supporting facts.

concerning diversity of life, photosynthesis and respiration, reproduction, and detecting the environment. The finding supports the assertion that our science teachers, being graduates in specific areas, are inadequately prepared to teach a broad and balanced junior science curriculum. To strengthen the subject matter knowledge and pedagogical skills of prospective and practicing junior science teachers, a number of provisions are suggested for teacher training programs, undergraduate science courses, and school-based activities.

Dikmenli (2010) tried to identify biology student teachers' misconceptions of cell divisions using drawings and interviews. An analysis of drawings and interviews suggested that biology student teachers have a series of significant problems and misconceptions regarding cell division and structuring of concepts in a meaningful manner. These problems were mainly associated with meiosis rather than mitosis. The students confused the stages of the cell division process and the events occurring at these stages. Some misconceptions identified from this study included that DNA replication occurs in the prophase during the cell division, interphase is the resting phase of mitosis, the chromosome number is doubled in prophase of mitosis and halved in anaphase of mitosis, the chromosome number remains the same during meiosis-I and it is halved during meiosis-II, and a chromosome has always two chromatids during cell division. These results were compared with related literature and recommendations were made for teachers and researchers for future studies to overcome students' misconceptions.

Prokop & Fančovičová (2008) state research into students' concepts about the human body has focused on several organ systems, but the reproductive system has been largely overlooked. The few studies that addressed children's concepts of birth were conducted mainly among kindergarten or primary school children. However, no study has yet attempted to examine how adolescent students perceive human pregnancy. Researchers administered a Human Pregnancy Understanding Questionnaire (HPUQ)

consisting of 50 Likert-type items to 300 university students in Slovakia. They found several misunderstandings of human fertilization, foetus respiration, and organ development. Moreover, several misconceptions found in Slovakian primary school children in the previous research still persist in adult students. Analysis of covariance shows that students' HPUQ scores were significantly affected by gender whereas females have better scores than males.

Maskour, Alami, Zaki, & Agorram (2019) conducted a questionnaire survey with undergraduate and master's students. The qualitative analysis of the students' responses made it possible to shed light on the difficulties of assimilation of many notions and also to identify the different misconceptions constructed during their learning courses about plant organisms. The findings indicate that some students are not motivated to take the course on plant classification because they perceive it as not important and not useful for learning other biology specialities. It was also noted that some of the students surveyed seem not to have acquired many concepts of plant biology including concepts related to the biology, reproduction and evolution of plants. The paper helped to see different types of problems in plant classification, which constitute misconceptions hindering learning.

Reiss (2018) state that reproduction is a key characteristic of all living organisms yet school biology often pays little or no attention to reproduction in taxa other than humans and a small number of 'typical' flowering plants. Researcher argued that there is still much value in a traditional introduction to life cycles and reproduction in a large range of taxa. He also considered such issues as the reasons why sex evolved and the diversity of ways in which sex is determined. The second topic addressed in his chapter is sex education, sometimes referred to as sex and relationships education. There is more to sex education than school biology education yet biology teachers can play an important role in sex education.

Stern, Kampourakis, Huneault, Silveira, & Müller (2018) stated that research in developmental psychology has shown that deeply-rooted, intuitive ways of thinking, such as design teleology[3] and psychological essentialism[4], impact children's scientific explanations about natural phenomena. Similarly, biology education researchers have found that students often hold inaccurate conceptions about natural phenomena, which often relate to these intuitions. The findings provide evidence for considerable persistence of teleological and essentialist misconceptions among students. They suggest future directions for thinking, studying, and analyzing students' conceptions about biological phenomena.

2.5. Research gap

Research gaps are the gap in knowledge seen in the field of concern. After reviewing the related literature, here are some gaps in studies identified.

- Research works done in misconceptions/ alternative conceptions in biology need to focus on misconceptions in reproduction, particularly, as recent studies on the same are missing.
- Concern of teachers towards misconceptions among students, should be focused in research works.

[3] The explanation of phenomenon in terms of the purpose they serve rather than of the cause by which they arise.

[4] It is the idea that certain categories, such as 'lion' or 'female' have an underlying reality which cannot be observed directly. Gelman (2004)