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A Study of Misconceptions in Science Among Students of Uttar Pradesh

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Abstract

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. Wrong information, misunderstanding or partial understanding of scientific concepts may lead to misconceptions among students. It is important to identify and address these misconceptions early on to develop deeper and more accurate understanding of concept. Therefore, the researchers have aimed to conduct the present study of identification of misconceptions in science among students. It is utmost important to first identify the misconceptions in science then only teachers can address these misconceptions through accurate information, effective explanations and hands on activities. For the present study, descriptive survey method and convenient sampling technique were employed. Quantitative analysis of data was done using frequency and percentage. The study revealed that misconceptions are prevalent among students. Girls have higher percentage of misconceptions as compared to boys. Majority of students from State Board have higher percentage of misconceptions as compared to their counterparts from CBSE board.

Key Words: Misconception, Science, Students

Introduction

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. According to Conant (1951) "Science is an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation". It has thus, now recognised that when children or adults learn science, conceptual understanding is a fundamental component of that learning. Researches around the world such as those of James (1989), Don (2011), Deshmukh (2012) indicated that even at the end of secondary school large numbers of students still held many ideas, or conceptions, which were not in accord with the way that scientists understood our world. These scientifically incorrect conceptions are called as misconceptions. Carey (2000) defines misconceptions as the inability of the students to apprehend scientific concepts correctly. Misconceptions play a major hindrance in students' learning and understanding as one misconception leads to another. Therefore, through this study the researchers had tried to identify the prevalence of misconceptions among students so that the measures of its refutation can be taken.

Need and Significance of the Present Study

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. Science is both a body of knowledge and the process of acquiring knowledge (Fitzpatrick, 1960). According to National Research Council (NRC, 1996) and American Association for the Advancement of Science (AAAS, 1990, 1993, 2000), scientific literacy is one of the foremost goals of science education. The major crux of National Curriculum Framework for School Education (2000 & 2005), National Curriculum Framework Review (2005), National Focus Group on Teaching of Science (2005) is to enhance the quality of science education and to develop proper understanding of scientific concepts among students. National Education Policy (2020) suggested incorporating some light text books as well as aspects of more formal but interactive classroom learning, in order to lay a solid groundwork across subjects of science and mathematics at preparatory stage to the addition of more abstract

concepts at middle stage to building greater depth across all the subjects at secondary stage. Science is involved in almost all the activities of our day-to-day life so the students must have correct understanding of scientific concepts. Incorrect or partial understanding of scientific concepts may tend to develop misconceptions among students.

Status of Science Teaching in India

In the last 15 to 20 years there has been a change in the way we think about elementary students' learning in science. The emphasis from the 1900's to the 1950's was on the learning of facts and repeating "classical scientific experiments" used to illustrate a particular point. 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". Umashree (1999) and Oglesby (2010) found that even at secondary level students are taught more through lecture method where emphasis is given on just cramming of facts rather than to get deeper understanding of the concepts. The emphasis from the 1960's to the 1980's and later, was on the process skills of science, such as observing, inferring, and predicting. The view that process was more important than content has changed as researches of (Jorgi, et al., 2007, Livingston 2017 & Geelan, et al., 2021) indicates the complexity of learning. Khalwania (1986) found that concept-based curriculum helped in better development of abstract concepts in students in comparison to conventional curriculum. Science now recognises that when children or adults learn science, conceptual understanding is a fundamental component of that learning.

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. Hence the researchers had decided to conduct their study with following research questions.

Research Questions

1. To know the status of misconceptions in science among students.
2. To know the extent of prevalence of misconceptions in science among students.

Statement of the Problem

Misconceptions in Science

Objectives of the Study

1. To study the prevalence of misconceptions in science among students with respect to
   a. Gender
   b. Type of Affiliation: State Board and CBSE Board

Operationalization of the Term

Misconception in Science: For the present study misconception refers to the incorrect answers given by the students in the Achievement Test administered on them.

Delimitation of the Study

The study was delimited to the selected Schools in Padrauna city of Kushinagar District, State of Uttar Pradesh. It was further delimited to standard VIII students of academic session 2021-2022.

Methodology of the Study

Descriptive Survey Method was adopted for the present study.

Sample

The researchers had adopted the convenient sampling technique. One school each from State Board and CBSE Board was selected for the present study. The reason for taking convenient sampling technique was that these two schools had granted permission to the researchers for conduction of the present study. There were two sections (A & B) of standard VIII in the State Board School. Each section had strength of 41 students. There were three sections of standard VIII (A, B & C) in the CBSE Board School. Each section had strength of 40 students. A detailed description of the sample for the present study is shown in the table below.

Table_ 1 Description of the Sample of the Study

Sr. No.	Type of School	Number of Students		
		Boys	Girls	Total
1	State Board	45	37	82
2	CBSE Board	64	56	120
	Total	109	93	202

Tools and Techniques of the Study

The researchers had prepared a multiple choice achievement test for the identification of misconceptions in science among students. The test contains items from Physics, Chemistry and

Biology. Content analysis of both CBSE and State Board books were done by the researchers prior to the preparation of the test. Items containing almost similar contents in both the books have been put in the test. Five items each from Physics, Chemistry and Biology were put in the test. Thus, the achievement test consisted of 15 closed ended items.

Data Collection

The researchers had personally collected the data from standard VIII students of State Board and CBSE Board in Padrauna city of Kushinagar district, state of Uttar Pradesh. The researchers had sought the permission for data collection from the principal of both the schools. An assurance was also given to them that data collected would be used for research purpose only and would be kept strictly confidential. Proper instructions were given to the students before starting of the test. The time duration given to the students for attempting this test was 15 minutes. Students were instructed to fill primary details such as their names, school names, class section, before they started attempting the questions. Following instructions were given to the students before starting of the test.

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

Data Analysis

The researchers had analysed the data quantitatively using frequency and percentage. While analysis the value has been approximated to its nearest percentage.

Table_2 Question Related to Misconceptions in Physics

Item No: 1. We can see an object because light travels from our eyes towards an object.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	37 (82)	8 (18)	33 (89)	4 (11)
CBSE Board	52 (81)	12 (19)	49 (88)	7 (12)

Item No. 1. We can see an object because light travels from our eyes towards an object is an incorrect concept. The correct concept is we can see an object when light travels from an object towards our eyes.

As shown in table 2, it has been observed that regarding item No. 1 out of 202 students, 89 (82 percent) boys and 82 (88 percent) girls found the above statement to be true whereas 20 (18 percent) boys and 11 (12 percent) girls found the above statement to be false. Thus, it can be concluded that girls from both the schools (State Board & CBSE Board) have higher level of misconceptions in comparison to their male counterparts. However, the girls from both the boards have almost similar level of misconception regarding item number one with a mere margin of one percent between both the schools (State Board & CBSE Board).

Table_3 Question Related to Misconceptions in Physics

Item No: 2. Heavy objects fall faster than lighter objects.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	39 (87)	6 (13)	32 (86)	5 (14)
CBSE Board	52 (81)	12 (19)	47 (84)	9 (16)

Item No. 2. Heavy objects fall faster than lighter objects is an incorrect concept. The correct concept is in the absence of air resistance all objects fall with the same acceleration due to gravity regardless of their mass.

As shown in table 3, it has been observed that regarding item No. 2 out of 202 students, 91 (83 percent) boys and 79 (85 percent) girls found the above statement to be true where as 18 (17 percent) boys and 14 (15 percent) girls found the above statement to be false. Thus, it can be concluded that most girls' student from State board lacks concept clarity regarding item number two.

Table_4 Question Related to Misconceptions in Physics

Item No: 3. Sound cannot pass through obstacles.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	29 (64)	16 (36)	33 (89)	4 (11)
CBSE Board	43 (67)	21 (33)	40 (71)	16 (29)

Item No. 3. Sound cannot pass through obstacles is an incorrect concept. The correct concept is when a sound meets an obstacle some of the sound is reflected back from the front surface and some of the sound passes into the obstacle material, where it is either absorbed or transmitted through the material.

As shown in table, it has been observed that regarding item No. 3 out of 202 students, 72 (66 percent) boys and 73 (78 percent) girls found the above statement to be true where as 37 (34 percent) boys and 20 (22 percent) girls found the above statement to be false. Thus, it can be concluded that regarding item number three girls from State Board have higher level of misconceptions in comparison to girls from CBSE Board.

Table_5 Question Related to Misconceptions in Physics

Item No: 4. Seasons are caused by Earth's distance from Sun.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	36 (80)	9 (20)	30 (81)	7 (19)
CBSE Board	48 (75)	16 (25)	45 (80)	11 (20)

Item No. 4. Seasons are caused by Earth's distance from Sun is an incorrect concept. The correct concept is seasons are caused by obliquity or axial tilt of the Earth rather than distance from the Sun.

As shown in table 5, it has been observed that regarding item No. 4 out of 202 students, 84 (77 percent) boys and 75 (81 percent) girls found the above statement to be true where as 25 (23 percent) boys and 18 (19 percent) girls found the above statement to be false. Thus, it can be concluded that girls from both the boards (State Board and CBSE Board) holds almost similar level of misconceptions were a mere margin of one percent.

Table_6 Question Related to Misconceptions in Physics

Item No: 5 Energy is either consumed or used up.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	43 (96)	2 (4)	29 (78)	8 (22)
CBSE Board	51 (80)	13 (20)	51 (91)	5 (9)

Item No. 5. Energy is either consumed or used up is an incorrect concept. The correct concept is energy is neither be used up nor consumed. It can only be transformed from one form to another.

As shown in table 6, it has been observed that regarding item No. 5 out of 202 students, 94 (86 percent) boys and 80 (86 percent) girls found the above statement to be true where as 15 (14 percent) boys and 13 (14 percent) girls found the above statement to be false. Thus, it can be concluded that both boys and girls from both the schools hold similar level of misconceptions regarding energy, however, girls from CBSE Board has higher percentage of misconceptions in comparison to girls from State Board.

Table_7 Question Related to Misconceptions in Chemistry

Item No: 6. Evaporation takes place only when there is sunlight.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	32 (71)	13 (29)	25 (68)	12 (32)
CBSE Board	47 (73)	17 (27)	33 (59)	23 (41)

Item No. 6. Evaporation takes place only when there is sunlight is an incorrect concept. The correct concept is evaporation can take place anywhere, even in the absence of sunlight.

As shown in table 7, it has been observed that regarding item No. 6 out of 202 students, 79 (72 percent) boys and 58 (62 percent) girls found the above statement to be true where as 30 (28 percent) boys and 35 (38 percent) girls found the above statement to be false. Thus, it can be concluded that boys from both the boards (State Board and CBSE Board) hold higher level of misconceptions than girls from both the boards. However, girls from State Board have higher percentage of misconceptions in comparison to girls from CBSE Board.

Table_8 Question Related to Misconceptions in Chemistry

Item No: 7. All acids are corrosive.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	27 (60)	18 (40)	30 (81)	7 (19)
CBSE Board	42 (66)	22 (34)	41(73)	15 (27)

Item No. 7. All acids are corrosive is an incorrect concept. The correct concept is strong acids are corrosive while weak acids are non-corrosive. For example, citric acid, found in citrus fruits is a weak acid and is safe for consumption in moderate amounts.

As shown in table 8, it has been observed that regarding item No. 7 out of 202 students, 69 (63 percent) boys and 71 (76 percent) girls found the above statement to be true where as 40 (37 percent) boys and 22 (24 percent) girls found the above statement to be false. Thus, it can be concluded that boys from CBSE Board hold higher percentage of misconceptions in comparison to their counterparts from state board where as girls from State Board have higher percentage of misconceptions in comparison to their counterparts from CBSE Board.

Table_9 Question Related to Misconceptions in Chemistry

Item No: 8. Salt dissolve in water only in powdered form.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	38 (84)	7 (16)	31 (84)	6 (19)
CBSE Board	58(91)	6 (9)	51 (91)	5 (9)

Item No. 8. Salt dissolve in water only in powdered form is an incorrect concept. The correct concept is salt can dissolve in water in various forms not just in powdered form. For example, salt can also dissolve in water when it is in crystal form.

As shown in table 9, it has been observed that regarding item No. 8 out of 202 students 96 (88 percent) boys and 82 (88 percent) girls found the above statement to be true whereas 13 (12 percent) boys and 11 (12 percent) girls found the above statement to be false. Thus, it can be concluded that among 202 students both boys and girls from hold similar level of misconceptions. However, both boys and girls from CBSE Board hold higher percentage of misconceptions in comparison of boys and girls from State Board.

Table_10 Question Related to Misconceptions in Chemistry

Item No: 9. All metals are magnetic.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	35 (78)	10 (22)	32 (86)	5 (14)
CBSE Board	57 (89)	7 (11)	52 (93)	4 (7)

Item No. 9. All metals are magnetic is an incorrect concept. The correct concept is magnets cannot attract all metals. It can only attract materials made up of iron, cobalt and nickel. Materials exclusively made up of copper, aluminium, silver and gold are non-magnetic

As shown in table 10, it has been observed that regarding item No. 9 out of 202 students 92 (84 percent) boys and 84 (90 percent) girls found the above statement to be true whereas 17 (16 percent) boys and 9 (10 percent) girls found the above statement to be false. Thus, it can be concluded that both boys and girls from CBSE Board has higher level of misconceptions in comparison to both boys and girls from State Board.

Table_11 Question Related to Misconceptions in Chemistry

Item No: 10. Chemical reactions occur only in laboratories.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	39 (87)	6 (13)	32 (86)	5 (14)
CBSE Board	53 (83)	11 (17)	47 (84)	9 (16)

Item No. 10. Chemical reactions occur only in laboratories is an incorrect concept. The correct concept is chemical reactions occur all around us both in nature and in our everyday lives. From the combustion of fuels in the vehicles to the rusting of metals chemical reactions are happening constantly.

As shown in table 11, it has been observed that regarding item No. 10 out of 202 students, 92 (84 percent) boys and 79 (85 percent) girls found the above statement to be true where as 17 (16 percent) boys and 13 (14 percent) girls found the above statement to be false. Thus, it can be concluded both boys and girls from State Board has higher level of misconceptions in comparison to boys and girls from CBSE Board.

Table_12 Question Related to Misconceptions in Biology.

Item No: 11. Seeds are non-living things.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	42 (93)	3 (7)	21 (57)	16 (43)
CBSE Board	62 (97)	2 (3)	37 (66)	19 (34)

Item No. 11. Seeds are non-living things is an incorrect concept. The correct concept is seeds are living things as they have the potential to develop into a fully functional plant when provided with necessary conditions.

As shown in table 12, it has been observed that regarding item No. 11 out of 202 students, 104 (95 percent) boys and 58 (62 percent) girls found the above statement to be true where as 5 (5 percent) boys and 35 (38 percent) girls found the above statement to be false. Thus, it can be concluded that boys from both the schools (State Board & CBSE Board) has higher level of misconceptions in comparison to girls from both the schools. However, girls from CBSE Board have comparatively higher level of misconceptions than girls from State Board.

Table_13 Question Related to Misconceptions in Biology.

Item No: 12. Human beings are not animals.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	40 (89)	5 (11)	25 (68)	12 (32)
CBSE Board	61 (95)	3 (5)	45 (80)	11 (20)

Item No. 12. Human beings are not animals is an incorrect concept. The correct concept is Human beings are the most evolved species of the animal kingdom.

As shown in table 13, it has been observed that regarding item No. 12 out of 202 students, 101 (93 percent) boys and 70 (75 percent) girls found the above statement to be true where as 8 (7 percent) boys and 23 (25 percent) girls found the above statement to be false. Thus, it can be concluded that boys from both the schools (State Board & CBSE Board) has higher level of misconceptions in comparison to girls from both the schools. However, girls from CBSE Board have comparatively higher level of misconceptions than girls from State Board.

Table_14 Question Related to Misconceptions in Biology.

Item No: 13. Heart lies at the left side of the chest.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	23 (51)	22 (49)	20 (54)	17 (46)
CBSE Board	33 (52)	31 (48)	31 (55)	25 (45)

Item No. 13. Heart lies at the left side of the chest is an incorrect concept. The correct concept is heart is not located on the left side of the chest. It is positioned slightly towards the left, but it is predominantly located in the centre of the chest.

As shown in table 14, it has been observed that regarding item No. 13 out of 202 students, 56 (51 percent) boys and 51 (55 percent) girls found the above statement to be true where as 53 (49 percent) boys and 42 (45 percent) girls found the above statement to be false. Thus, it can be concluded that girls from both the schools (State Board & CBSE Board) has higher level of misconceptions in comparison to boys from both the schools.

Table_15 Question Related to Misconceptions in Biology.

Item No: 14. Plants only get food from the soil.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	41 (91)	4 (9)	27 (73)	10 (27)
CBSE Board	56 (88)	8 (12)	35 (63)	21 (37)

Item No. 14. Plants only get food from the soil is an incorrect concept. The correct concept is plants require nutrients from the soil for their growth but they also produce their own food through photosynthesis.

As shown in table 15, it has been observed that regarding item No. 14 out of 202 students, 97 (89 percent) boys and 62 (67 percent) girls found the above statement to be true where as 12 (11 percent) boys and 31 (33 percent) girls found the above statement to be false. Thus, it can be concluded that boys from both the schools (State Board & CBSE Board) has higher level of misconceptions in comparison to girls from both the schools. However, girls from State Board have comparatively higher level of misconceptions than girls from CBSE Board.

Table_16 Question Related to Misconceptions in Biology.

Item No: 15. All bacteria are harmful.				
Student	Boys		Girls	
	True (%)	False (%)	True (%)	False (%)
State Board	43 (96)	2 (4)	29 (78)	8 (22)
CBSE Board	58 (91)	6 (9)	43 (77)	13 (23)

Item No. 15. All bacteria are harmful is an incorrect concept. The correct concept is while some bacteria can cause diseases but not all bacteria are harmful. In fact many bacteria are beneficial and play important roles in the environment such as helping with digestion in our intestine or decomposing organic material.

As shown in table 16, it has been observed that regarding item No. 15 out of 202 students, 101 (93 percent) boys and 72 (77 percent) girls found the above statement to be true where as 21 (7 percent) boys and 31 (23 percent) girls found the above statement to be false. Thus, it can be concluded that boys from both the schools (State Board & CBSE Board) has higher level of misconceptions in comparison to girls from both the schools.

Major Findings of the Study

The major findings of the study are as follows:

1. Misconception is prevalent among students of both State Board and CBSE Board.
2. Students of State Board have higher percentage of misconceptions as compared to CBSE Board.
3. Misconceptions is prevalent among both boys and girls student.
4. Girls student have higher percentage of misconceptions as compared to boys.
5. Majority of boys have higher percentage of misconceptions in Biology.
6. In one item of Biology (Item No. 13) majority of girls have higher percentage of misconceptions as compared to boys.
7. In most of the items of Biology students from State Board have higher percentage of misconceptions as compared to their counterparts from CBSE Board.
8. Most of the girls have higher percentage of misconceptions in Physics.
9. In one item of Physics (Item No. 2) majority of boys have higher percentage of misconceptions as compared to girls.

10. In most of the items of Physics students from State Board have higher percentage of misconceptions as compared to their counterparts from CBSE Board.
11. Majority of girls have higher percentage of misconceptions in Chemistry.
12. In one of the items of Chemistry (Item No. 6) boys have higher percentage of misconceptions as compared to girls.
13. In one of the items of Chemistry (Item No. 7) boys from CBSE board have higher percentage of misconceptions as compared to their counterparts from State Board whereas girls from State Board have higher percentage of misconceptions as compared to their counterparts from CBSE Board.
14. In one of the items of Chemistry (Item No. 8) both boys and girls have similar percentage of misconceptions.
15. In two of the items of Chemistry (Item No. 6 & 10) students from State Board have higher percentage of misconceptions as compared to students from CBSE Board.
16. In two of the items of Chemistry (Item No. 8 & 9) students from CBSE Board have higher percentage of misconceptions as compared to students from State Board.

Discussion of the findings

Identification of misconceptions in science among students is essential for promoting accurate knowledge, scientific literacy, critical thinking, informed decision-making and countering the spread of misinformation. The present study findings revealed that majority of girl students have higher level of misconceptions as compared to boys. Similar kind of result can be seen from the study conducted by Gray (2007) who opined that girls have more problems with misconceptions than boys do. He further stated that it remains a serious problem in science education that girls are being inadequately trained to question and reflect on their science understandings. In the present study it was found that girls have higher level of misconceptions as compared to boys on topic of Earth science and natural phenomenon. Similar kind of result can be seen from the study conducted by William (1993) who conducted a survey of eighth grade Earth Science students' misconceptions about fundamental Earth Science ideas. In his study he also found that girl students have higher level of misconceptions as compared to boys. In the present study it was also found that majority of students from State Board have higher percentage of misconceptions as compared to their counterparts from CBSE board. Similar kind of result can be seen from the study conducted by

Sopapun (1994) who found that there were significant differences in misconceptions among eighth grade students from different types of schools.

Misconceptions in science among students can stem from variety of factors such as improper instructional practices, lack of hands-on experiments, over or under simplification of scientific concepts, misinterpretation of scientific concepts leading to incomplete or incorrect understandings. With all the consideration & observation from above discussion, we can arrive at a point that it is crucial to address these misconceptions in order to foster a better understanding and appreciation of the scientific method and its contributions to our understanding of the natural world.

Conclusion

Based on above findings, it can be concluded that misconceptions are prevalent among students. Girls have higher level of misconceptions as compared to boys. Students from State Board have higher level of misconceptions as compared to students from CBSE Board. Boys have higher level of misconceptions in Biology whereas girls have higher level of misconceptions in Physics. In chemistry both boys and girls have almost similar level of misconceptions. Thus, it can be concluded that misconceptions in science is prevalent at a higher extend among students.

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