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A Study on Misconceptions in Cell Division and Reproduction among Secondary School Students in Relation to Their Preferred Teaching Styles

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ABSTRACT

Understanding of concepts is very important in science learning, the lacking of which leads to development of misconceptions among students. Teaching styles influence the conceptual understanding among students and can lead to development of misconceptions. The objectives of the study were – to identify misconceptions in cell division and reproduction among secondary school students and to determine the relationship of misconception in cell division and reproduction with their preferred teaching styles. A sample of 550 secondary school students in present descriptive study was randomly selected from different schools in Kanpur District, U.P. India. The standardized tool used for data collection were Cell Division and Reproduction Diagnostic Test. and Teaching Style Inventory. Data were analysed using descriptive statistic (mean, percentage) and inferential statistics (Pearson correlation). The finding of the study revealed several misconceptions in cell division and reproduction and the percentage of misconceptions in mitosis, asexual reproduction, meiosis, sexual reproduction, chromosome and organelles and regeneration, a significant positive relationship between preferred teaching styles and misconceptions in cell division and reproduction among secondary school students was also found. Based on these finding, some implications are being made that will help teachers to identify and remediate misconceptions among their students.

Key Words : Cell ivision, Reproduction, Teaching styles

INTRODUCTION

Science education primarily includes teaching and learning of science at school level. Conceptual understanding is must to develop true understanding of the scientific facts and phenomenon. It is generally believed that students come to the class with their own understanding about concepts or phenomenon of the science which are not in accordance with establish scientific facts. This is termed as misconceptions. A view or opinion resulting from the faulty thinking or inaccurate understanding is termed as misconception. In other words, it is a mistaken belief resulting from experience in scientific idea or phenomenon (Cartelli, 2003; Thompson and Logue, 2006). Numerous terminologies are used such as erroneous ideas, naïve beliefs, preconceptions or alternative conceptions, alternative frameworks, etc. (Wandersee, Mintzes and Novak, 1994). However most commonly used term is misconceptions. Hammer (1996) mentioned misconception as the cognitive structure to change, affects students understanding of scientific concepts.

Misconceptions in sciences are very common. Students come across a number of experiences everyday which led to the development of understanding related to some scientific phenomena or concepts. However, all developed understanding is not always in accordance with established facts or phenomena, these are termed as misconception. There are several reasons such as Students usually follow memorisation process rather than

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comprehensive synthesis of process involved. Proper demonstrations, teaching aids were not properly used and implied in teaching- learning process, illustrations of scientific terms were not given properly, background knowledge related to concept were not analysed by the teachers, sometimes teachers also have misconceptions that were transfer to the students.

There are number of abstract concepts in biology such as cell division; reproduction genetics are very abstract. Secondary school students being the first timer to these concepts are unable to understand it in accordance with in scientific phenomenon. A number of researches had reported different misconceptions in cell biology : misconceptions related to cell organelles (Duda, Jago and Adpriyadi, 2020); structure-functions of the cell (Suwono and Fachewnnisa, 2021); mitosis, meiosis and mutations (Kumundas *et al.,* 2018) and phases of cell division, chromosomes and chromatids number, how gametes are formed (Chattopadhyay, 2012).

The art of teaching is a constructive approach. It makes effort to arrange and maintain classroom learning, establish learning environment that allows students to create their own understanding (Blanch-Payne, 2000). Teachers' behaviour with students' interaction within teaching-learning process determines their teaching styles (Grasha, 1996). Teachers' education and confidence has a significant relationship with students' misconceptions (Qian, Hambrusch and Li, 2019). Lack of confidence and insufficient knowledge are some reasons to blame teachers for misconceptions among students (Jarvis, Mckeon, 2005).

Teaching being an essential part in developing conceptual framework among the students. Influence of different teaching styles on student learning can't be denied. Results evident that extensive work had already been done to determine the relationship between misconceptions in biology at student and teacher's level. But not much consideration is given to determine the influence of preferred teaching styles of students on misconceptions in biology. In a science classroom of a variety of teaching methods and strategies required to teach the variety of concepts in science. Biology is no exception to it, where number of concepts are abstract appropriate teaching style must be adopted to develop the correct conceptual understanding among the students. Therefore, in present study the researcher determined relationship of teaching styles on misconceptions in cell division and reproduction.

Objectives of the study:

1. To identify the misconceptions in cell division and reproduction among secondary school students
2. To study relationship of misconceptions in cell division and reproduction with preferred teaching style among secondary school students.

Research questions:

1. What are the misconceptions in cell division and reproduction among secondary school students?
2. Is there any significant relationship of teaching styles and misconception in cell division and reproduction among secondary school student.

METHODOLOGY

The present study is the descriptive survey research. The population of the study includes secondary school students. A sample of 550 (232 male, 318 female) secondary school students from different school in Kanpur district, is selected using random sampling technique.

Tools :

In order to identify the misconceptions in cell division and reproduction, a three-tier diagnostic test, Cell Division and Reproduction Diagnostic Test constructed by Harika Ozge Arsalan (2014) is used. The test consists of 20 items based on mitosis, meiosis, sexual reproduction, asexual reproduction, chromosomes and organelles and regeneration. The first tier is simple multiple-choice question with two choices, the second tier consist of reasons for the first-tier item and third tier is about confidence level for above two tiers. The scoring of test was done according to the scoring method explained by Arsalan (2012). According to Arsalan (2012) scientific knowledge was defined as having the right answers to the first two tiers and being certain in third tier. Misconception are defined as incorrectly answered questions to any or both of the first two tiers with certainty in third tier. False positives and false negatives, phrases used to describe assessment mistakes in scientific research. A false positive is when an effect is discovered that is not truly there, while a false negative is when an effect that is genuinely there is not revealed. Therefore, choosing the correct answer on the first tier but giving the incorrect justification on the second tier along with certainty were treated as false positives in the current study, while choosing the incorrect answer

Table 1 : Alternative Sets for Misconceptions in Concepts of Cell Division and Reproduction

Areas of Misconception	Misconceptions	Alternative sets for misconceptions
Mitosis	M1	1.1 b, 1.2 b, 1.3a; 1.1 b, 1.2 c, 1.3 a 1.1 a, 1.2 c, 1.3 a; 7.1 a, 7.2 b, 7.3 a; 1.1 b, 1.2 d, 1.3; 1.1 a, 1.2 e, 1.3 a; 3.1 b, 3.2 a, 3.3 a; 3.1 b, 3.2 b, 3.3 a; 3.1 b, 3.2 e, 3.3 a; 6.1 a, 6.2 c, 6.3 a; 3.1 b, 3.2 d, 3.3 a; 7.1 a, 7.2 a, 7.3 a; 7.1 b, 7.2 c, 7.3 a; 7.1 b, 7.2 e, 7.3 a; 8.1 b, 8.2 a, 3.3 a; 8.1 b, 8.2 d, 8.3 a; 9.1 b, 9.2 a, 9.3 a; 9.1 b, 9.2 b, 9.3 a; 9.1 b, 9.2 d, 9.3 a; 9.1 a, 9.2 e, 9.3 a; 9.1 b, 9.2 f, 9.3 a; 10.1 a, 10.2 a, 10.3 a; 10.1 b, 10.2 b, 10.3 a; 10.1 a, 10.2 d, 10.3 a;10.1 c, 10.2 d, 10.3 a; 10.1 b, 10.2 e, 10.3 a
Asexual Reproduction	M2	4.1 b, 4.2 a, 4.3 a; 4.1 a, 4.2 b, 4.3a; 2.1 b, 2.2 a, 2.3 a; 2.1 b, 2.2 b, 2.3 a; 11.1 b, 11.2 b, 11.3 a; 2.1 a, 2.2 d, 2.3 a; 2.1 a, 2.2 e, 2.3 a;
Meiosis	M3	6.1 b, 6.2 d, 6.3 a; 8.1 a, 8.2 c, 8.3 a; 6.1 b, 6.2 e, 6.3 a; 11.1 b, 11.2 b, 11.3 a; 11.1 b, 11.2 d, 11.3 a; 12.1 c, 12.2 a, 12.3 a; 12.1 b, 12.2 d, 12.3 a; 12.1 a, 12.2 c, 12.3a; 13.1 b, 13.2 a, 13.3 a; 13.1 b, 13.2 b, 13.3 a; 13.1 b, 13.2 d, 13.3 a;13.1 b, 13.2 e, 13.3
Sexual Reproduction	M4	14.1 b, 14.2 a, 14.3 a; 14.1 b, 14.2 b, 14.3 a; 14.1 b, 14.2 c, 14.3a; 14.1 a, 14.2 e, 14.3 a; 15.1 a, 15.2 a, 15.3 a; 15.1 b, 15.2 c, 15.3 a; 15.1 a, 15.2 e, 15.3 a; 15.1 a, 15.2 b, 15.3 a; 15.1 a, 15.2 e, 15.3 a;15.1 b, 15.2 c, 15.3 a; 18.1 a, 18.2 a, 18.3 a; 18.1 a, 18.2 c, 18.3 a
Chromosomes and Organelles	M5	5.1 a, 5.2 b, 5.3 a;5.1 a, 5.2 c, 5.3 a; 5.1 a, 5.2 d, 5.3 a; 16.1 b, 16.2 a, 16.3 a; 16.1 a, 16.2 b, 16.3 a; 16.1 b, 16.2 d, 16.3 a; 16.1 b, 16.2 e, 16.3 a; 17.1 b, 17.2 a, 17.3 a; 17.1 a, 17.2 b, 17.3 a; 17.1 a, 17.2 e, 17.3 a; 20.1 a, 20.2 a, 20.3 a; 17.1 b, 17.2 c, 17.3 a; 20.1 a, 20.2 c, 20.3 a; 20.1 a, 20.2 d, 20.3 a
Regeneration	M6	19.1 b, 19.2 a, 19.3 a; 19.1 b, 19.2 c, 19.3 a; 19.1 a, 19.2 d, 19.3 a

Adapted from Arsalan (2014)

on the first tier but giving the proper justification on the second tier along with certainty were treated as false negatives.

Misconception score was calculated by taking first two tiers in Table 1 and students' responses into account. Misconception in concepts of cell division and reproduction are coded as- Mitosis- M1; Asexual Reproduction; Meiosis- M3; Sexual Reproduction- M4; Chromosomes and Organelles-M5 and Regeneration-M6. Average percentage for each misconception was produced by taking score of first two tiers of all items included in each concept.

The reliability score calculated by constructer of the test is .78, by researcher on secondary school students from Kanpur district is .73.

To determine the preferred teaching styles among the secondary school students Teaching Style Inventory developed by Anthony F. Grasha in 1996 was used. The scale consists of 40 items. The scale classifies teaching styles into five categories- expert style, facilitator style, formal authority style, personal model style, delegator style. To know the teaching style of teachers, the mean score for each dimension is calculated. The scale was designed for teachers. To know the preferred teaching styles of secondary school students the scale is adapted by researcher. Reliability score = .75 calculated by researcher on selected sample of secondary school students in Kanpur district.

RESULTS AND DISCUSSION

The average percentage score for each area of misconception provides a general idea of amount of misconception in Cell Division and Reproduction as presented in Table 2. It is evident that students have a misconception in concepts related to cell division and reproduction. Average percentage score for misconception in mitosis is 56.36%, misconceptions in asexual reproduction is 53.81%, misconceptions in meiosis is 42.86%, misconceptions in sexual reproduction is 54.5%, misconceptions in chromosomes and cell

Table 2 : Average Percentage of Misconceptions in Cell Division and Reproduction

Sr. No.	Areas of Misconception	Misconceptions	Average Percentage
1	Mitosis	M1	56.36
2.	Asexual Reproduction	M2	53.81
3.	Meiosis	M3	42.86
4.	Sexual Reproduction	M4	54.5
5.	Chromosomes and Organelles	M5	49.63
6.	Regeneration	M6	54.36

organelles is 49.63% misconceptions in regeneration is 54.36% represents a high level of misconceptions among the secondary school students.

Item-wise analysis for alternative sets of misconceptions revealed following misconceptions in concepts of cell division and reproduction-

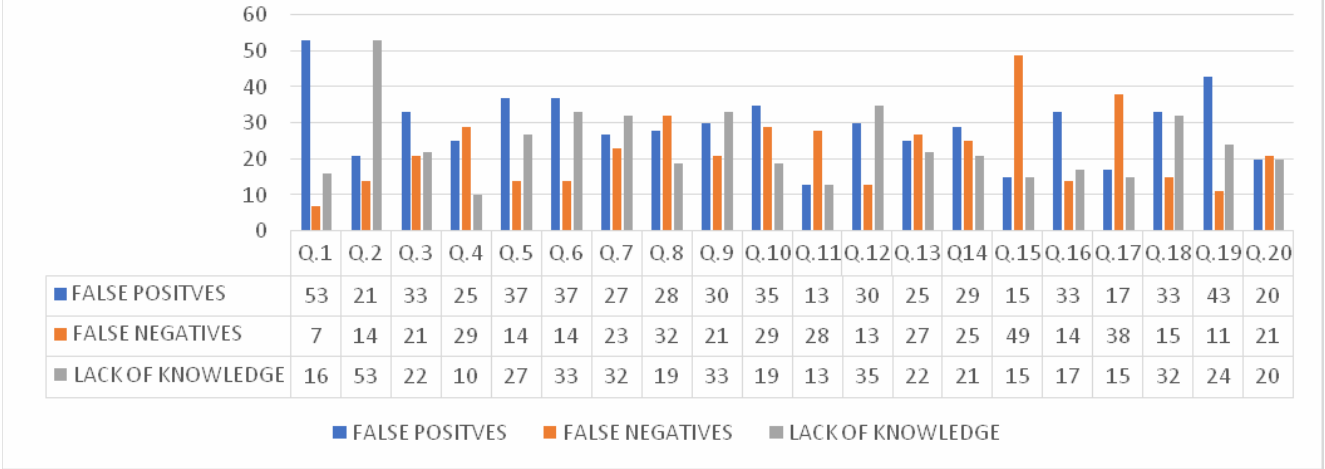
- In mitosis the amount of chromosomal DNA is different in different stages.
- The number of chromosomes is fixed and remained unchanged during the stages.
- Spindle fibres are only formed by centromeres
- Both homologous chromosomes and sister chromatids separate and the number of chromosomes halves in two times.
- Crossing over is the only way to provide genetic diversity
- Homologous chromosomes and sister chromatids are essentially the same thing.
- Sexual reproduction must involve mating.
- Diploid zygote can be developed without fertilization.
- Gametes are diploid.
- Gametes mother cells are haploid.
- Centrioles are located in the nucleus of the cell but move to cytoplasm after the nucleus cell wall dissolves.
- Genetic diversity can be provided by regeneration.
- Fertilization occurs in parthenogenesis.

To further investigate the misconceptions, percentage score for item were analysed for false negatives and false positives shown on Fig. 1.

From Fig. 1 results reveal that students have more percentage for false positives than false negative. Therefore, suggests that students have a problem in understand the phenomenon for the scientific concept. Factual information is clearly understood by the student but they are not able to comprehend the details related to phenomenon. In other words, students know the fact but they don't know the reason behind it. Being a very abstract concept sometimes students are not able to understand. Lack of proper teaching techniques, appropriate teaching materials students' prior knowledge can be the probable reasons for development of inappropriate understanding among the students. Item-1, 4, 8, 11, 13, 15, 17 have higher percentages of false negatives. The percentage is more than 10 %, represents that responses are not because of carelessness for the students. It means some of the items are subtle and problematic for some students.

Study of relationship between teaching styles and misconceptions is presented in table below in Table 3.

The correlation coefficient value shows a highly positive significant relation between teaching styles and misconceptions in cell division and reproduction. The expert style of teaching style has r-value= .079 (significant at .05 level of significance), the facilitator style of teaching has r-value= .38 (significant at .01 level of significance). The other styles, formal authority with r-value= .04, personal model with r-value = .03, delegator with r-value= .07 are insignificant. The result reveal that some of the teaching styles show significant positive linear relationship



	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10	Q.11	Q.12	Q.13	Q14	Q.15	Q.16	Q.17	Q.18	Q.19	Q.20
FALSE POSITVES	53	21	33	25	37	37	27	28	30	35	13	30	25	29	15	33	17	33	43	20
FALSE NEGATIVES	7	14	21	29	14	14	23	32	21	29	28	13	27	25	49	14	38	15	11	21
LACK OF KNOWLEDGE	16	53	22	10	27	33	32	19	33	19	13	35	22	21	15	17	15	32	24	20

Fig. 1 : Percentage for false positives and false negative

Table 3 : Correlation Coefficient between teaching styles and misconception in Cell division and reproduction

Misconceptions	Teaching Styles					
	Total	Expert	Formal Authority	Personal Model	Facilitator	Delegator
Cell Division and Reproduction	.09*	.079*	0.04	0.03	.38**	0.07

*Significant at.05 level ** significant at .01 level

with Misconceptions for Concept of Cell Division and Reproduction. On the basis of result, it can safely infer that the teaching styles affects the Misconceptions for concept of Cell division and Reproduction at Secondary School Level. Teacher has a significant role to play in process of teaching and learning.

Conceptual understanding is must to know and understand the scientific phenomenon. In cell biology majority of the concepts seems to be abstract in nature, as hands on experiences cannot be provided. Results evident that misconceptions are common in scientific enquiry. Mitosis, meiosis, regeneration, cell organelles basic topics under the heading cell biology. Findings of the study revealed a high level of misconceptions in concepts of mitosis, meiosis, sexual- asexual reproduction, Chromosomes and organelles, Regeneration. Abundant literature reported misconceptions in these concepts. Stewart *et al.* (1991) reported students' misconceptions in understanding of chromosomes and chromatids. Brown (1990) examined misconceptions in meiosis, misconceptions about abstract nature of genetic concepts (Knippels, 2002; Tekkaya, Ozkan, Sungur, 2001). It would therefore seem that students enter their studies with a range of misconceptions and frequently depart with many of them uncorrected. By supplying pupils with factual information, it is hoped that they would think critically. To rectify discipline-inconsistent ideas, it seems insufficient to examine biological concepts. It has also been proposed that misconceptions have a detrimental effect on the acquisition of new knowledge. They are not simply resistant to conventional teaching methods. Teacher methods holds direct control over the learning process, hence teaching methods should be analysed and accordingly chosen according to the nature and demand of the concept.

In a classroom teaching- learning process starts with teacher. Results of study reveals a significant relationship between styles and misconceptions among secondary school students. Teaching styles of the teacher is very prominent factor in developing correct understanding among the students. It determines the behaviour of the teacher, teaching method and strategies adopted by teacher in a classroom. Therefore, teacher should be aware of her teaching styles and should adopted flexible approach in teaching different concepts. Prior knowledge of the students should be proper analysed, teaching aids and teaching methods should be properly organised according to the students' metacognitive structure.

Cell division and reproduction is base concepts for the higher learning in cell biology if the students don't have correct conceptual understanding, they won't be able to comprehend the complex concepts in cell biology. School management and teacher should make effort to find and rectify misconceptions among students.

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