

A STUDY OF STUDENTS' MISCONCEPTIONS IN BIOLOGY AT THE SECONDARY SCHOOL LEVEL

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The purpose of this study was to investigate the misconceptions amongst students and to identify the possible sources of misconceptions. A search in the literature reveals that textbooks, reference books, teachers, language, cultural beliefs and practices are some of the principal sources of high school students' misconceptions of many science concepts including biology. Results of the study show that there is an urgent need for research based material to rectify students' misconceptions. In a survey, it is observed that, high school students displayed an anthropocentric view about biological concepts. A more general misconception amongst the students was their tendency to explain all the physiology terms like respiration, excretion, photosynthesis, fertilization etc. exclusively with reference to humans or animals. Research shows that misconceptions about processes of respiration, photosynthesis, circulation persist across grade levels.

INTRODUCTION

Research on students' conceptions has proliferated in the last twenty years and enhanced our understanding about the preconceptions, misconceptions and alternative conceptions that students bring with them to the classroom. By now, it is well accepted that alternative conceptions and misconceptions are common among students and that these interfere with subsequent learning and are resistant to change. Overcoming misconceptions is crucial to student learning. When misconceptions are challenged directly and students are provided with opportunities to re-construct their world-view, the proportion of students able to use science conceptions to explain phenomena increases significantly (Fisher and Wandersee, 2001).

Studies related to the students' misconceptions are being conducted seriously all over the world. In India studies related to students' misconceptions in physics, chemistry and mathematics are being done but not in biology. Therefore, a study of students' misconceptions in biology conducted at secondary school level has great significance.

DESIGNING A QUESTIONNAIRE AND DATA COLLECTION

This research is aimed to study the students' misconceptions in biology with respect to life processes, which is the syllabus at secondary school. An open-ended test was administered to the students of class IX. This study was conducted in two schools, one urban and one rural school having English as the medium of instruction, located in Thane Region. The selection of these schools was made using Simple Random Sampling procedure. The sample comprised 110 secondary students aged 16 to 18 years from two high school classes. Of the total sample, 51 were girls and 59 boys.

After each question enough blank space was provided for students to express their opinions in detail. It had following eight questions:

1. Why is heart known as an important organ?
2. What is the exact meaning of respiration?
3. Does breathing and respiration mean the same?
4. Do the processes of photosynthesis take place during the day whereas respiration takes place only at night?
5. How do you define the term food?
6. Why is eating an important animal activity?
7. What happens if a person eats only carbohydrates for one month?
8. Why are vitamins essential?

DATA ANALYSES AND DISCUSSION

Responses to these questions were analysed separately. The salient findings of the analyses are presented below:

Responses to Q. 1 revealed that many students did not have a lucid notion about the function of heart. It has been found that a large number of students (41) mentioned that heart converts impure blood into pure blood. 21 students mentioned that heart pumps pure blood to different parts of the body. They stated that heart is important as it is responsible for inhaling and exhaling processes. Surprisingly, only a few (6) had the obvious understanding about the function of heart.

Misconceptions about human physiology have been associated with the way teachers and textbooks presents information and with the incorrect use of language in class. Findings suggest that students are unable to apply models to physiological situations or are missing critical facts such as the right and left ventricle contracting at the same time. Misunderstanding about human blood circulation can escalate when elementary or secondary school teachers hold their own misconceptions (Barrass, 1984).

Regarding Q. 2 and Q. 3, students were expected to write the exact meaning of respiration, and the difference between breathing and respiration. It was observed that most of the students (47) did not see any difference between breathing and respiration. They mentioned that respiration means breathing. Some students (17) mentioned that, respiration is a process of taking oxygen in and giving carbon dioxide off. Few students (16) also mentioned that, respiration is observed only in animals and humans.

A common misconception found amongst the students' in biology is that respiration and breathing are the same process. However, terms respiration refers to cellular metabolism and breathing refers to the inhalation and exhalation of air. Students have probably heard that our lungs are a part of the respiratory system, which can add to the confusion of these terms. The notion of cellular respiration is difficult enough to grasp for students since they cannot see it occur. However, terms like 'respiratory system', 'respiratory surface' and 'respiratory centre', in which 'respiratory' actually means 'breathing', are still commonly used. This is a main source of confusion to students. Not only

students' but also teachers' misconception on various physiological processes are due partly to the tendency of some authors to define such terms almost exclusively in relation to animals particularly humans (Driver, 1987).

Regarding Q. 4, it was observed that majority of students (56) mentioned that photosynthesis takes place during the day whereas respiration takes place only at night and in plants. According to them, the plants photosynthesize during the day and conduct cellular respiration only at night. They however, think that cellular respiration is a continuous process. Similar misconceptions are also found among college students (Wandersee, 1983).

In response to Q. 5 and Q. 6 a large number of students (34) described that food gives energy, nutrients, carbohydrates etc. and it is used to fill stomach. Some students (27) expressed that food is eaten/consumed to make us strong. Many students (59) answered that, digestion is a characteristic of animals. Students preconceptions of food are centred on satiation ("to fill stomach"), general well-being ("for health and nourishment") and for life and living ("to live and grow"). They have thus completely, missed the critical point of eating food.

Simpson and Arnold (1982) found that 14-16 year old students mentioned the provision of energy in relation to food., Most of the answers are "food can be eaten, is consumable, contains nutrients, foods are prerequisites for survival". This is attributed to children being told to "eat well" or to "eat up to grow big" and thus food is often associated with growth. Bishop, Roth and Anderson (1986) caution against accepting student responses such as "food is energy" since students often confuse the notion of conservation of matter/energy in respiration and photosynthesis.

Bishop, Roth and Anderson (1986) caution against accepting student responses such as "food is energy" since students often confuse the notion of conservation of matter/energy in respiration and photosynthesis. Therefore, in their opinion the concept of food should be dealt in functional terms as organic matter which provides energy for tissue metabolism and allocation of stored energy for growth.

Q. 7 & Q. 8 are associated with balanced diet. Both questions seek content knowledge and are well-answered by 78 students. Some students mentioned that the person would lose weight whereas some other are convinced that the opposite would happen. Q. 8 focused on the function of vitamins. It is observed that 83 students mentioned that vitamins give energy and supply nutrients and according to 28 students, vitamins provide proteins, fats and carbohydrates.

CONCLUSIONS AND IMPLICATIONS

1. Teacher Preparation- The study reveals that many students possess misconceptions in basic biology knowledge. The reasons may be their upbringing and home environment. Textbooks may also be responsible unknowingly. Thus, the responsibility of the teachers increases considerably. Traditional modes of instructional delivery and assessment may not reveal misconceptions that interfere with learning. The drawing, writing, and mainly oral debate protocols expose student thinking as they present their evidence and construct explanations. Therefore, to produce competent and effective science teachers, the science education courses should be overhauled so that prospective science teachers will teach the school level science topics correctly. The science

methods have a leading role to play in this regard to improve science teaching. This can be done during the science methodology courses of prospective and practicing science teachers

2. Use of innovative techniques: Traditional methods of teaching are not sufficient in overcoming student misconceptions. New innovative techniques and models of science instruction must be practiced by teachers such as cooperative learning strategies, Inquiry training model, web-quest etc. In 1989, the Biological Science Curriculum Study (Binghamton University, New York) group developed the 5E Model of instruction. The 5E cycle 1) focuses on major misconceptions, 2) begins with an 'engage' phase that requires active participation by students, 3) moves to additional phases that develop and expand the information and ideas, 4) but with much of the articulation done by the students, and 5) ends with an 'evaluate' phase that emphasizes student synthesis and/or application, plus self-assessment, more than grade reports.

Educators, therefore, must help students to overcome their misconceptions by diagnosing the misconceptions, creating dissatisfaction with the misconceptions, and providing opportunities to practice the goal conceptions.

3. Curriculum Modification- Misconception may arise when teaching fails to induce a conceptual change among the students. It is necessary to prevent them from occurring. Certain prerequisite concepts are necessary for a learner to develop genuine understanding of a certain concept. This consideration suggests that, it is crucial to consider the logical structure of the subject matter. The curriculum planners and the text book writers need to be extra cautious in this regard. The teacher should take into account the students' prior knowledge; identify the misconceptions before curriculum transaction. Some misconceptions seem to arise from the students' inability to use concepts in novel situations. Students tend to restrict their understanding to the particular context, in which the concept is learned. To overcome this problem, teachers should provide opportunities for students to apply a learned concept in different contexts. Science teachers, students and authors must be made aware of such misconceptions presented in biology textbooks which teachers and students use without questioning.

4. Development of Enrichment Material- To promote effective and meaningful learning, we need to identify the causes of such misconceptions and find ways to rectify them. To achieve this goal, research based material is very crucial. It will help teachers, and students to overcome misconceptions and other barriers of understanding. The use of such a material will certainly bring significant changes in conceptions and improved understanding in all the topics, teachers dealt with (Amir and Tamir, 1990).

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