

IDENTIFICATION OF MISCONCEPTIONS ABOUT PLANT HELD BY SENIOR SECONDARY SCHOOL STUDENTS IN ILORIN METROPOLIS, NIGERIA

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Abstract

In this descriptive survey study, misconceptions about plant held by secondary school biology students in Ilorin were identified. The population of the study consisted of all the biology students in the 40 public secondary schools in Ilorin metropolis. Only 191 students that were randomly selected from 20 out of the 40 public secondary schools part in the study. Simple random sampling technique was used to select the schools and the students. Data gathering was carried out through the use of an instrument designed by the researchers entitled "Students' Conceptions about Plant Test". The reliability coefficient of the instrument was 0.64. Results of the study indicated that the students held 26 misconceptions about plants, categorized into seven categories. Over simplification and conceptual confusion were the most prevalent types of miscomputation held by the students while the most frequent source of the misconceptions was didasklogenic. The paper advocated the use of meta-cognitive strategies such as the Study Technology by the teachers and students alike during teaching and learning process. Also, it called upon biology teachers to provide students with adequate knowledge of plants such that they can contribute meaningfully to the global efforts on combating climate change.

Keywords: Biology Education, Biology Teachers, Biology Students, Students' Misconceptions, Science Education, and Plant.

Introduction

Biology, the scientific study of living organisms, is a core subject in Nigerian secondary school curriculum. Biology arguably has the most significant impact on the life of every individual globally compared to other science subjects. Indeed, the European Union Forum (2011) rightly noted that without the study of biology, epidemics diseases cause by some viruses and bacteria such as Ebola and Bubonic plague could have wiped out the whole of mankind. In the view of Milford (n. d.) the study of biology 'is one of the fundamental reasons why the human race has progressed and thrived over the last 2000 years. Its importance to mankind should never be underestimated since it touches every facet of human existence. No matter what we do biology is intrinsically involved in our day-to-day lives. Given the immense impacts of biology on human beings, it is not surprising that biology educators and researchers are worried about the abysmal performance of students in the subject. Students' misconceptions of biology concepts are one of the major reasons adduced for the students' poor achievement in biology by researchers. (Abimbola 2013; Altunolu, & Seker, 2015; Singer, 2015)

The term 'misconception' is often used to describe ideal held by individual that is not compatible with that held by the scientific community. Misconceptions is also referred to as misunderstood word, naive theory or wrong idea. According to Coley and Tanner (2015) cognitive and developmental psychologists noted that human uses the intuitive conceptual

system to reason about the living world. Intuitive conceptual systems refer to the use of teleological, essentialist, and anthropocentric thinking to provide explanations about the natural world. Coley and Tanner (2015) conducted a study on students' misconceptions in biology. The results of the study indicated linkages between the pupils' intuitive conceptual system of thinking and their misconceptions in discipline-based reasoning.

Plants are multicellular organisms characterized by the possession of chloroplast, a pigment that enables them to convert solar energy into food through a complex process called photosynthesis. As rightly noted by Johnson and Coburn (2010) and the United States Geological Survey (n.d.) plants play crucial role in biological sequestration, a process through which carbon dioxide is removed from the atmosphere or reduce its emission. Biological sequestration helps to stabilize the concentration of greenhouse gas in the atmosphere thereby mitigating climate change, which is a major threat to the survival of human and other forms of life. It is evident from the foregoing that plants play invaluable roles in the sustainability of life on the earth. It is thus imperative for human to possess a meaningful understanding of plant as part of measures to combat climate change. However, students are noted to possess misconceptions about plants in their cognitive structures. For instance, Hershey (2004) documented 50 misconceptions about plant held by students. Also, Vitharana (2015) identified 18 misconceptions about plants held by Sri Lanka Students, while the Ohio State University (2009) documented several misconceptions about plants held by American students.

Several frameworks were used in science education literature (Bello, 1998; Boo, 2006; Coley & Tanner, 2012; Hershey, 2004; Sesen, 2010; Wikipedia, 2014) to categorized students' misconceptions. Some of the common categories of students' misconceptions include:

- (a) *Teleological thinking*: It is simply reasoning based on the assumption that events and everything around us have purposes, end or aim. In the field of biology teleology is often applied inappropriately such that biological structures and phenomena are explained by the presupposed functions, goals, or purposes;
- (b) *Typological thinking*: The basic assumption in typology is that there exist unobservable essential property that is common to all members of a category, which gives the category identity and underlies the observable attributes. Its application in biology led to the assumption that biological structure, species, and system have a core property that determines its observable features and identity;
- (c) *Anthropocentric*: A way of thinking based on a misapplication of analogical reasoning strategy. Anthropocentric thinking created the tendency to explain unfamiliar biological structure, species, system and processes by analogy to humans.
- (d) *Perceptual confusion*: Perceptual process provides the sensory experience of the world around us. Perceptual confusion occurs in situation where two patterns are mistakenly identified as each other;
- (e) *Semantic confusion*: This occurs when a word is wrongly perceived as one that has a similar meaning;
- (f) *Over generalization*: It refers to the logical fallacy that occurs when conclusion about a group is based upon unrepresentative sample
- (g) *Over simplification*: The act of making something seem simpler than it is, in an

attempt to make the thing easy to understand. It is the act of presenting an explanation that excludes detail information.

Statement of the Problem

Misconceptions of biological concepts constitute a substantial obstacle to the realization of the goals of biology education as revealed in several studies (Abimbola 2013; Altunølu, & Seker, 2015; Singer, 2015; Vitharana, 2015). In Nigeria, several misconceptions studies on biology concepts have been carried out as reported by Abimbola (2013), but there seems to be no sufficient studies targeted directly at identifying students' misconceptions of the plants. There are indications that Nigerian students also held misconceptions about plants. For instance, the West African Examinations Council Chief Examiners' Report (2013) indicated that the few students that attempted questions on plants were reported to have performed poorly due to misconceptions. Therefore, the focus of this study was to identify misconceptions about plants held by biology students in Ilorin metropolis as part of measures to promote meaningful learning in biology.

Purpose of the Study

The purpose of this study was to identify misconceptions about plants held by the senior secondary school biology students in Ilorin metropolis. Specifically, the study attempted to;

- (i) Determine whether secondary school biology students in Ilorin hold misconceptions about plants;
- (ii) Identify and classify the misconceptions about plants hold by the students;
- (iii) Determine the most prevalent category of students' misconceptions about plants;
- (iv) Determine the probable sources of the identified students' misconceptions about plants; and
- (v) Identify the most prevalent source of students' misconceptions about plants.

Research Questions:

The following research questions were raised and answered in the study:

- (i) Do senior secondary school biology students in Ilorin metropolis hold misconceptions about plant?
- (ii) What are the various categories of misconceptions about plants that the senior secondary school biology students in Ilorin metropolis holds in their cognitive structures?
- (iii) What is the most prevalent category of misconceptions about plant that the senior secondary school biology students in Ilorin metropolis holds in their cognitive structure?
- (iv) What are the sources of the identified students' misconceptions about plants?
- (v) What is the most prevalent source of the identified students' misconceptions about plants?

Methodology

Research Design: The study adopted the descriptive survey research design.

Population of the Study: The study population consisted of all the biology students in the 40 public secondary schools in Ilorin Metropolis.

Sample and Sampling Technique: Simple random sampling method was used to select 20 secondary schools from the list of 40 public secondary schools within Ilorin metropolis. Also, simple random sampling method was used to select ten biology students in their second year of the senior secondary school education programme (SSS II students) from each selected school. *Research Instrument:* The researchers designed a test called Students' 'Conceptions about Plant Test', to collect data in the study. The instrument consisted of ten

items which required the students to provide short open-ended response. Students were expected to complete the test within a duration of one hour and thirty minutes.

Validity and Reliability of the Research Instrument: One senior lecturer in the field of biology education, and two experienced secondary school biology teachers helped to determine the face and content validity of the research instrument. The reliability coefficient of the instrument was determined through the test-retest technique and was found to be 0.64.

Method of Data Collection: Data collection was carried out through the administration of the research instrument (Conceptions about Plant Test). The researchers employed the service of biology teachers in the 20 selected secondary schools to administer the instrument to the 200 selected students however, only one hundred and ninety-one (191) students took part in the test. The responses of the students to the questions in the test were the data gathered in the study.

Method of Data Analysis: The students' responses to the questions in the Conceptions about Plant Test were subjected to qualitative analysis through identification of misconceptions about plants contained in the responses. The identified students' misconceptions about plants were grouped into seven categories based on the existing frameworks in science education literature. Three biology education lecturers helped to validate the identified misconceptions held by the students. The list of the identified students' misconceptions about plants was revised based on the input of the validators. The identified students' misconceptions about plants were then subjected to quantitative analysis. Simple percentage computation was used to analyse the prevalence of each type of misconceptions held by the students.

Results

The results of the data analyses were summarised and presented in the tables.

Research Question 1: Do senior secondary school biology students in Ilorin metropolis hold misconceptions about plant?

Twenty- six misconceptions about plant were identified in this study. Table 1 presents the list of the misconceptions. Based on the foregoing, it is evident that the biology students held misconceptions about plants. This finding provides the answer to research question 1

Table 1: Misconceptions about plant held by senior school biology students in Ilorin metropolis

No	Misconceptions	Categories	Sources
1	Plants are living things that own their food by themselves with the aid of some enzymes	Anthropocentric	Didaskologenic / Textbooks
2	Plants breathe in oxygen and breathe out carbon dioxide like us	Anthropocentric	Didaskologenic / Textbooks
3	Plants don't make use of oxygen because they don't breath in like us	Anthropocentric	Intuitive Naivety
4	Plants cannot respond to stimulus because they cannot feel any touch	Anthropocentric	Intuitive Naivety
5	The survival of other organisms depend on Plants because they are the most populous organism	Overgeneralization	Didaskologenic / Textbooks
6	Plant is the only source of food	Overgeneralization	Didaskologenic / Textbooks

7	Plants breathe in carbon dioxide and breathe out oxygen.	Oversimplification	Didaskologenic / Textbooks
8	Plant do respire through one part present on the leave alone	Oversimplification	Didaskologenic / Textbooks
9	Plant feeds through sunlight in the sky	Oversimplification	Didaskologenic / Textbooks
10	Plants excrete by breathing out oxygen only	Oversimplification	Didaskologenic / Textbooks
11	Plants use carbon dioxide to produce energy alone	Oversimplification	Didaskologenic / Textbooks
12	Carbon dioxide is the only gas that plants consume	Oversimplification	Didaskologenic / Textbooks
13	Plants are living things that their colour is green	Perceptual confusion	Didaskologenic / Textbooks
14	Plants feed when they are being wet by someone or raining day	Perceptual confusion	Intuitive Naivety
15	Plants excrete by removing old parts e.g. leaves to grow new once	Perceptual confusion	Intuitive Naivety
16	Insects and plants is a parasitic association so insect feeds on flowers	Perceptual confusion	Didaskologenic / Textbooks
17	Plants response to stimuli because when we push plants they tend to move little bit	Perceptual confusion	Intuitive Naivety
18	Water move in and out of the plants when watering them	Perceptual confusion	Intuitive Naivety
19	Plants do respire through the process of photosynthesis	Semantic Confusion	Semantic Confusion
20	Relationship between butterfly and plant is a mutualism and symbiosis association	Semantic confusion	Semantic Confusion
21	They makes use of oxygen in the process of transpiration	Semantic confusion	Semantic Confusion
22	Plants are like animals which produce food for the consumption of man	Teleological thinking	Didaskologenic / Textbooks
23	Plants use soil in other for them to grow	Teleological thinking	Intuitive Naivety
24	Butterfly benefits from the plants that is why they are always their because plants give food	Teleological thinking	Intuitive Naivety
25	The survival of other organisms depend on Plants because plant fertilize the soil	Teleological thinking	Didaskologenic / Textbooks
26	Plants breathe just because is among living things	Typological thinking	Intuitive Naivety

Research question 2: What are the various categories of misconceptions about plant that the senior secondary school biology students in Ilorin metropolis hold in their cognitive structures?

The 26 misconceptions about plant that were held by the biology students were in seven categories as shown in Table 1. This finding provided the answer to research question 2 posed in this study.

Research Question 3: What is the most prevalent category of misconceptions about plant that senior secondary school biology students in Ilorin metropolis held in their cognitive structure?

Table 2 presents the prevalence of each category of misconceptions identified in this study. It indicated that Oversimplifications and Perceptual confusion were the most prevalent categories. This result provided the answer to the third research question raised in this study.

Table 2: Prevalence of categories of students' misconceptions about plant

SN	Categories of Misconceptions	Frequency (%)
1	Typological thinking	1 (3.84)
2	Overgeneralization	2 (7.69)
3	Semantic Confusion	3 (11.53)
4	Anthropocentric	4 (15.38%)
5	Teleological thinking	4 (15.38%)
6	Oversimplifications	6 (23.07)
7	Perceptual confusion	6 (23.07)
	Total	26 (100%)

Research Question 4: What are the sources of the identified students' misconceptions about plants?

The identified misconceptions about plants are traceable to four probable sources as presented in Table 1. This finding provided the answer to research question 4 raised in this study.

Research Question 5: What is the most prevalent source of the identified students' misconceptions about plant?

The most prevalent source of the students' misconceptions is didaskologenic. Fourteen out of the twenty-six (53.84%) students' misconceptions about plants established in this study were probably from didaskologenic source as indicated in Table 3. This finding provided the answer to research question 5.

Table 3: Prevalence of sources of students' misconceptions about plant

SN	Sources of Misconceptions	Frequency (%)
1	Didaskologenic / Textbooks	14 (53.85)
2	Intuitive Naivety	9 (34.62)
3	Semantic Confusion	3 (11.53)
	Total	26 (100%)

Discussions

As stated earlier, findings from this study revealed that secondary school biology students in Ilorin metropolis holds seven categories of misconceptions about plants. Results of many earlier studies (Bello, 1998; Boo, 2006; Coley & Tanner, 2012; Hershey, 2004; Sesen, 2010) had also identified these categories of misconceptions. Students' misconceptions about plants is a clear indication of their inadequate knowledge of plants. Given the significant role of plants in mitigating climate change, biology teachers should provide students with adequate knowledge of plants such that they can contribute meaningfully to the global efforts on combating climate change.

Biology is a unique science subject with a number of biology –specific principles or concepts that distinguished it from physical sciences. For instance, typological thinking is not applicable in every areas of biology as is the case in physical sciences. Population thinking is the new framework that replaced typology principle in modern biology, it stresses that every individual is unique and differs from all others. Although analogical reasoning is a legitimate tool of the mind in science as explained by Abimbola (2006). Whenever analogy is poorly

used it can result into learning difficulties such as anthropocentric category of misconceptions. Usually spontaneously generated analogies often lack the criteria for credibility. Teleology is an essential philosophical foundation of many established religions such as Christianity and Islam, consequently teleological thinking is a widespread cognitive construct that at least tentatively helps individuals to make sense of the world around us. References to the supposed functions, goal, or purposes of structures and processes in organisms tend to re-enforce teleological way of thinking that the students had already inappropriately extended into biology.

Results of this study indicated that oversimplification and perceptual confusion are the most prevalent categories of misconceptions held by the biology students. This calls to question the level of pedagogical content knowledge of the biology teachers, because they ought to realize that oversimplification is akin to providing students with distorted information thereby creating what is referred to as 'steep or skipped gradient' in the field of Study Technology. A steep gradient is a barrier to learning according to Abimbola (2015). Oversimplification is also, very common in biology textbooks, as noted by Hershey (2004). Perceptual confusion could be the results of lack of exposure of the students to sensory experiences through hand-on and mind-on activities. This suggests that biology teachers are most likely not allowing the students to interact with the actual physical objects and biology specimens during class lessons thereby creating a barrier to learning referred to as a lack of 'Mass' in the field of Study Technology.

Findings from this study identified semantic confusion as another category of misconceptions held by the students. Semantic confusion is an indication of lack of meaningful understanding of concept words, this is referred to as 'misunderstood word' in the field of Study Technology, it is considered to be the most significant barrier to learning. Abimbola (2015) identified lack of mass, steep or skipped gradient, and misunderstood word as the three major barriers to learning. It is obvious from the findings of this study that students had encountered the three major barriers to learning. Metacognitive strategies such as Study Technology could be used to overcome barriers to learning and also, learning how to learn for meaningful understanding.

Results of this study indicated that didaskologenic is the most prevalent source of the identified students' misconceptions about plants. Earlier studies (Bello, 1998; Boo, 2006; Wikipedia, 2014) on students' misconceptions in biology had also identified didaskologenic, intuitive naivety and semantic confusion as sources of students' misconceptions. Didaskologenic stems from overgeneralization and oversimplification of biology concepts by the teachers. It is thus, necessary for the biology teachers to avoid instructional strategies that could lead to oversimplification and overgeneralization statements on biology concepts

Summary of the Major Findings

- (i) Twenty-six misconceptions about plants were held by senior secondary school biology students in Ilorin metropolis.
- (ii) The categories of misconceptions held by the biology students are, Anthropocentric, Overgeneralization, Oversimplifications, Perceptual confusion, Semantic Confusion, Teleological thinking, and Typological thinking
- (iii) Oversimplifications and Perceptual confusion are the most prevalent categories of misconceptions held by the senior secondary school biology students.
- (iv) The identified students' misconceptions about plants are traceable to didaskologenic, Textbooks, Intuitive Naivety and Semantic confusion sources.
- (v) The most prevalent source of the identified students' misconceptions about plant is didaskologenic.

Conclusion

Given the foregoing findings, the study concludes that senior secondary school biology students in Ilorin metropolis held misconceptions about plants in their cognitive structures. The existence of misconceptions about plants in the students' cognitive structures indicated that they encountered major barriers to learning during class lessons on plants. The seven categories of misconceptions held by the students include, Anthropocentric, Overgeneralization, Oversimplifications, Perceptual confusion, Semantic Confusion, Teleological thinking, and Typological thinking. The most prevalent categories of misconceptions were an oversimplification and perceptual confusion while the most common source was didasklogenic.

Recommendations

Based on the findings of this study, the following recommendations were made:

- (i) Biology teachers should avoid using typology framework to provide explanations during class lessons;
- (ii) It is important for biology teachers to be sensitive to the misleading applications of typology in biology and recognize that secondary school biology textbooks often contain subtle typological statements;
- (iii) Biology teachers should teach their students how to recognize and avoid using typological explanations;
- (iv) Biology teachers should not use spontaneously generated analogies that lack the criteria for credibility to avoid anthropocentric misconceptions;
- (v) References to the supposed functions, goal, or purposes of structures and processes in organisms should not be made by the biology teachers to avoid re-enforcing teleological way of thinking that the students had already inappropriately extended into biology;
- (vi) Biology teachers should always identify students' pre and post instructional misconceptions, and expose them to conceptual change strategies to eliminate the misconceptions;
- (vii) Biology students should learn and employ Study Technology metacognitive strategies to enable them overcome barriers to learning and also, learning how to learn for meaningful understanding;
- (viii) Biology teachers should provide students with adequate knowledge of plants such that they can contribute meaningfully to the global efforts on combating climate change; and
- (ix) Students should be regularly exposed to sensory experiences through hand-on and mind-on activities to prevent a lack of 'Mass' and perceptual confusion.

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