An Assessment of Refutational Text Features of Biology Textbooks and Student's Misconceptions in the Concepts of Photosynthesis and Respiration in Plants

Noma Vanessa DAVID-EGBENUSI (MRS) PhD
Department of Curriculum and Instructional Technology
Faculty of Education
University of Benin
noma.david-egbenusi@uniben.edu
08023660532

Abstract

This study investigated whether or not Refutational Text features are available in the common biology textbooks used in teaching Biology. Three research questions were raised to guide this study and a hypothesis was formulated. The survey research design was employed; four biology textbooks were randomly selected from a population of eight textbooks, while 129 students took an achievement test to identify if misconceptions exist in the concepts of Photosynthesis and Respiration in plants from a total population of 1333 Students. Two instruments were adopted for the study, namely; Refutational Text Features Instrument (RTFI) and Test on Photosynthesis and Respiration in Plants (TPRP). (RTFI) was designed to investigate if the features of the refutational texts were present in the selected Textbooks while (TPRP) identified the misconceptions that students have in the concept of Photosynthesis and Respiration in Plants. Reliability coefficient were found to be 0.8128 using Inter-rater Analysis for RTFI and 0.07 using Kuder-Richardson formula 20 for the TPRP. Data were analyzed using Descriptive Statistics of Percentage, means and Standard Deviation for the research questions and ANOVA for the hypothesis. Findings revealed that the students had misconceptions in the concept of Photosynthesis and Respiration in Plants and the four biology textbooks did not have Refutational Text Features. Teachers and science educators should plan their lesson to address misconceptions that students have in Biology and the lesson note to reflect Refutational Text Features.

Keywords: Misconceptions Refutational, Textbooks, Features, Teachers

Introduction

Biology is one of the courses of study in science education curriculum and an important subject not only for studying how living things work, but to benefit human beings. Biology education equips learners with the basic knowledge and skills that are essential in the study of medicine, pharmacy, Nursing, Brewing, Microbiology and other related disciplines. However, reports over the years consistently have indicated that poor performances of Nigerian secondary school students at the West African Senior School Certificate Examinations (WASSCE) had always existed as reflected in the Chief Examiner's Annual Reports for 2015, 2016, 2017, 2018, and 2019 (West African Examinations, 2021) and 2022. The annual reports

observed many types of diagram errors in candidates' answer scripts; Wrong spelling of labels and technical terms; Student's inability to spell technical terms; Inability to articulate points correctly; Lack of in-depth understanding of biological terms; Poor understanding of concept; Misconceptions; Teaching methods and Errors from Biology textbooks among other factors.

Textbooks are indispensable curricular resources especially in developing nations like Nigeria where most students have limited access to other learning resources. Students and teachers often depend on textbooks as a reliable source of knowledge and skills as noted by Novitasari *et al.* (2019). Sunarmi & Sari (2021) noted that textbooks are still the main source of information in the learning process. They opined that the fact is that there are still many errors in the textbooks used in schools as teaching materials used by students and teachers. Their research showed that of the 3 Biology textbooks studied, there were 5 misconceptions, 9 principle errors, and 10 errors in writing scientific names. An online newspaper The Times of India published that National Council of Educational, Research and Training (NCERT) also accepted 11 mistakes in Biology textbooks of Classes XI and XII. "With these corrections, the total number of corrections done by the NCERT in Biology textbooks till date had risen to 124. Other errors that can lead to misconceptions include: Textbooks errors in writing scientific names of organisms, which can be confusing and lead to misidentification. Ganiyu (2021) noted that some selected Nigerian practical biology textbooks were laden with various types of diagram errors that could impact students' performance negatively. Specifically, Photosynthesis and respiration in plants, for instance, have been identified as topics were students have several misconceptions.

Photosynthesis and respiration, for instance, has become a core scientific topic in Biology that plays a critical role in environmental issues. Photosynthesis produces the oxygen to replenish the ones used up by living organisms during the process of respiration. On the other hand, carbon dioxide is produced during the process of respiration that necessitates plants to perform photosynthesis. However, several misconceptions in the learning of this topic have been identified. Throughout the years, misconceptions about photosynthesis and plant respiration are well documented (Köse, 2008; Cullinane & Liston, 2011; Svandova, 2014; Galvin *et al.*, 2015). For instance, Marmaroti and Galanopoulou (2007) revealed that most Greek students aged 13 found that photosynthesis is a very difficult Biology topic because of the conflicting information they obtain about photosynthesis and respiration. Misconceptions in photosynthesis and respiration in plants will prevent students' meaningful and permanent learning; it seriously impacts students' future learning. Such misconceptions hinder students from learning more advanced concepts. Furthermore, when students' initial understanding is not carefully resolved, they may fail to grasp new concepts and information presented in the classroom and simply learn for the purpose of passing a test and thus, relate and apply their misconceptions outside the classroom.

Researchers have developed interventions that can help correct the errors that exist in biology textbooks and clear misconceptions. Such intervention is known as conceptual change texts. An example of a conceptual change text is the Refutational text. It is as an intervention in teaching which has been found to be effective in clearing misconceptions. Refutational text can be defined as a written passage that describes a certain misconception, argues why it is incorrect, and then explains the scientifically correct concept. Refutational texts are designed and structured to state a common misconception, explicitly refute the misconception, and then present the accepted scientific viewpoint as a plausible and fruitful alternative. Often the format includes a written passage that describes a certain misconception, argues why it is incorrect, and then explains the scientifically correct view. Refutational text presents the commonly associated misconceptions, refutes it by explaining why it is not a scientifically acceptable concept, and provides an explanation of the scientific conception. Guzzetti (1997) have proposed that the effectiveness of Refutational text lies in its ability to create cognitive conflict by contrasting the correct ideas with the incorrect ones. A textbook is considered to have high extent when it has the three features of a Refutational Text and Low extent when it has none of the features of Refutational Text.

Therefore, this study intends to investigate the format in which biology textbooks are written in the concept of Photosynthesis and Respiration in Plants. It specifically analyzed the biology textbooks commonly used in Secondary Schools as recommended by WAEC syllabus. This study investigated whether these biology textbooks are Refutational in nature. A textbook that is Refutational in nature have features such as; Texts highlighting misconceptions, the texts refuting the misconceptions and the text explaining the correct scientific views of a concepts. Finally, the study will investigate if biology students have misconceptions in the concept of Photosynthesis and Respiration in Plants.

Statement of Problem

Poor academic performance in biology has been attributed to various factors including educators, their teaching methods, teaching materials and lack of teaching materials. Errors and misconceptions have also been identified as other reasons for the poor performances witnessed amongst students. Throughout the years, misconceptions about photosynthesis and plant respiration are well documented (Marmaroti & Galanopoulou, 2007; Köse, 2008; Cullinane & Liston, 2011; Svandova, 2014; Galvin *et al*., 2015). It is therefore important to identify these misconceptions and develop strategies to provide student with the accurate conceptual knowledge. If these misconceptions are not detected and corrected immediately, they will adversely affect the students' subsequent learning. Since textbooks are the dominant resource for science instruction in most classrooms, text-based methods of facilitating conceptual change need to be examined. It therefore becomes necessary to provide student's opportunities and interventions to help change such misconceptions especially those misconceptions which originate from textbooks. Broughton (2012) believe that interventions such as discussion,

demonstration, concept mapping, reading of conceptual change texts, narrative texts and Refutational texts are effective strategies because they promote high cognitive engagement.

Guzzetti, Hynd, Skeels, and Williams (1995), asked the following questions; "Why it is that students don't like using their science textbooks? Are certain types of texts liked more than others? Are some types of texts more believable? What do students find confusing about textbooks and the way information in textbooks is presented? How would students like to see their textbooks improved?" (76%) of the honors students reported that they never or rarely used the textbook beyond completing the assigned problems in each chapter. This may be due to the fact that textbook do not really relate with student's prior knowledge. So the students see the textbooks as just a tool to help them give back what will satisfy the teachers. This becomes worrisome because science teachers and students rely heavily on science texts for most of their teaching and learning respectively. This perhaps partially accounts for several studies in the field of science education on textbook analysis. Vojíř and Rusek (2019) noted that publications on textbook analysis are increasing, and that researchers in Europe and the USA carried out more works on textbook analysis than researchers from other regions of the world and that secondary school science textbooks were the most researched on. Previous studies on biology textbook analysis such as (Bhatti *et al*., 2015; Candra *et al*., 2020; Lestari & Zulyusri, 2021; Nair, 2019; Novitasari *et al*., 2019; Raharjo *et al*., 2018; Ramnarain & Padayachee, 2015; Sunarmi & Sari, 2020) revealed that biology textbooks are often laden with diagram errors, misconceptions, inaccurate content presentation, curricular issues, and other forms of inaccuracies.

Svandova (2014) found that many lower secondary students do not even understand the fundamental concept that photosynthesis and plant respiration have mutually connected physiological functions. They understand photosynthesis is an integral constituent of processes that are taking place in the green parts of plants, primarily in the leaves. However, they do not understand the function and presence of chlorophyll, even though they know that chlorophyll is a necessary constituent of photosynthesis. Jayanti and Rahayu (2019) found similar misconceptions about photosynthesis and respiration, indicating that misunderstandings regarding these topics were not properly resolved. Similar results found that misconceptions about photosynthesis and respiration in plants still exist among junior high school students, leading to the conclusion that photosynthesis and respiration are the most frequently investigated misconception in science learning (Anjarsari, 2018).

In addition to the general criticisms, expository textbooks contain too many concepts and present ideas in a list-like fashion. Science teaching is mostly meaningful when the prior knowledge of the learners is recognized and considered. The conceptual change approach proposes that if students are to change their ideas they must become dissatisfied with their existing conditions (dissatisfaction), new concepts must provide a better explanation and be understandable (intelligible), these concepts must appear to propose solutions to problems and

must be in accordance with knowledge in other ideas and be believable (plausible), and they must lead to new insights (Posner *et al*, 1982). Refutational text is one such text that addresses the prior knowledge of learners and are very effective in changing students' misconceptions.

This study therefore investigated whether the commonly used biology textbooks employed in teaching biology in secondary schools in Edo State have Refutational Texts Features (RTF) in them. Do biology textbooks state/highlight the misconceptions biology students may have in the concept of Photosynthesis and Respiration in plants? Are there biology textbooks that refute misconceptions that may exist in the concept of Photosynthesis and Respiration in plants? What misconceptions of the concept of Photosynthesis and Respiration in plants exist among biology students?

Research Questions

The following research questions were raised to guide the study:

1. To what extent do biology textbooks on Photosynthesis and Respiration have Refutational Texts Features in commonly used biology textbooks?
2. What percentages of biology students have Misconceptions of the concept of Photosynthesis and Respiration in plants?
3. Is there a significant difference in the Refutational Texts Features of the different textbooks used for teaching the concept of Photosynthesis and Respiration in Plants?

Research Hypothesis

Research Hypothesis one and two were answered while research question three was hypothesized as follows;

1. There is no significant difference in the Refutational Text Features of different textbooks used for teaching the concept of Photosynthesis and Respiration in Plants.

Methodology

The survey research design was employed to access the perceptions of 30 biology students in Senior Secondary School two (SS 2) to establish which biology textbooks had Features of Refutational Texts (FRT) in the concept of Photosynthesis and Respiration in Plants. The population for this study consisted of eight (8) biology textbooks commonly used for teaching biology as approved by the Ministry of Education and 1333 Secondary School Students from 18 co-educational government in Oredo Local Government Area of Benin City. The simple random sampling technique was used to select four (4) biology textbooks and 129 students from the population. The two instruments used are Refutational Text Features

Instrument (RTFI) and Test on Photosynthesis and Respiration in Plants (TPRP). RTFI was designed to accommodate the desired outcome which reflects the characteristics and features of the refutational texts. RTFI is a six page instrument made up of three parts. The first part is made up of two sections which sought information about the sex of the rater (student). The second section of the first part of the RTFI consists of four Likert scale questions ranging from Highly, Moderately, Lowly to None. These four options measured the extent to which questions asked applied to the individual rater. The second part of the RTFI is a list of common misconceptions on Photosynthesis and Respiration in Plants that student may likely come into the classroom with. These common misconceptions are the items the raters are to look out for in the texts on the third part of the RTFI. The third part of RTFI is made up of texts on Photosynthesis and Respiration in Plants extracted from each of the four biology textbooks been investigated in this study. The reliability co-efficient of RTFI was found to be 0.8128 using Inter-Rater Analysis.

The Second instrument TPRP was designed to identify the misconceptions that students have in the concept of Photosynthesis and Respiration in Plants. TPRP consists of fifteen (15) two-tier diagnostic test items. The test is a combination of multiple-choice questions with reasons, adopted from "What do You Know About Photosynthesis and Respiration in Plants?" developed by Haslam and Treagust (1986), and standardized West Africa Examination Council (WAEC) examination questions. Each question has two parts–Part I is an objective question with four options A, B, C and D, followed by Part II which consist of four (4) reasons to the correct option in Part I. In both parts, a correct answer and reason is included. A student is considered to have the correct conception when the right answer and reason are ticked. A misconception is identified when the student picks the right answer but the wrong reason or a wrong answer but a right reason. A correct conception with (50%) scores was considered as pass mark. Summarily; Right Answer and Right Reason means Correct Conception, Right Answer and Wrong Reason means Misconception, Wrong Answer and Correct Reason means Misconception, Wrong Answer and Wrong Reason means Misconception. These questions were carefully selected to identify right conceptions or misconceptions in limited but clearly defined content area. The Kuder-Richardson formula 20 (KR 20) was employed to obtain the reliability coefficient value of 0.70. Research questions were analyzed using Descriptive statistics of mean and standard deviation, and percentages while the hypotheses were tested using One Way Analysis (ANOVA) at 0.05 significant level.

Results

Research Questions 1: What percentage of students identified the sampled textbooks with Features of Refutational Texts in commonly used biology textbooks?

Table 1: Percentage of Biology Texts on Photosynthesis and Respiration with Features Refutational Text

Textbooks		Frequency	Percent
COLLEGE BIOLOGY	Low Extent	29	96.7
	High Extent	1	3.3
ESSENTIAL BIOLOGY	Low Extent	29	96.7
	High Extent	1	3.3
MODERN BIOLOGY	Low Extent	29	96.7
	High Extent	1	3.3
NELSON BIOLOGY	Low Extent	29	96.7
	High Extent	1	3.3

From Table 1, the responses from 29 of thirty 30 students showed that the four textbooks had low extent of RTF. Only one student answered that the four textbooks on Photosynthesis and Respiration in plants had RTF. Figure 1 shows a graphical representation of the Biology Texts on Photosynthesis and Respiration in plants with RTF.

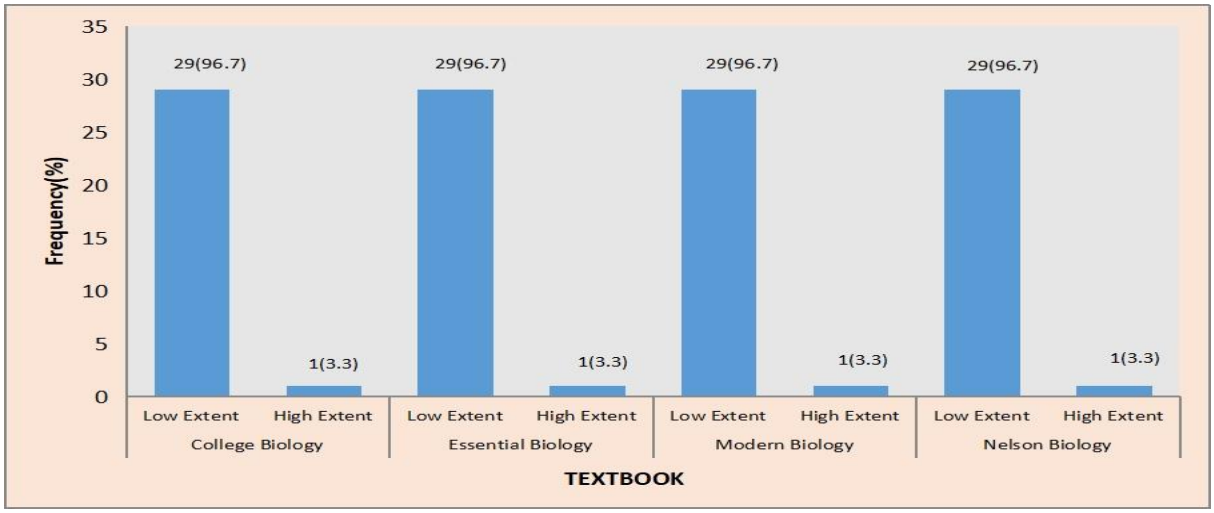

Figure 1: Biology Texts on Photosynthesis and Respiration in Plants with Refutational Text Features

From the illustration in figure 1, the percentage of textbooks with low RTF was very high at (96.7%). This shows that most biology textbooks on Photosynthesis and Respiration in Plants do not inform users such as teachers and students that misconceptions exist in the topic. The textbooks do not refute these misconceptions and they do not explain the scientific views of the misconception that exist in the concept of Photosynthesis and Respiration in Plants.

Research Question 2: What percentage of biology students have misconceptions in the concept of Photosynthesis and Respiration in Plants?

The Chart in Figure 2 and results on Table 2 shows the percentage of students with Misconceptions in Photosynthesis and Respiration in Plants.

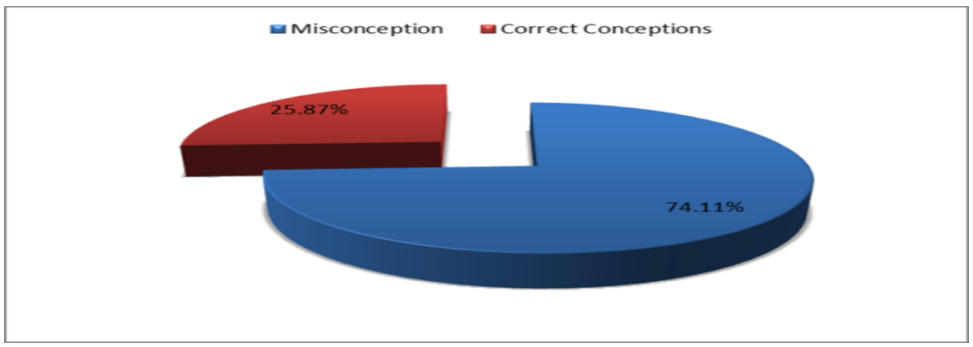

Figure 2: Percentage of Students with Misconceptions and Correct Conceptions of Photosynthesis and Respiration in Plants.

Results from the chart show that a majority of the students, with an average of 74.11 percent had misconceptions in all the test items over and above the (25.87%) of students with correct conceptions of the concept of Photosynthesis and Respiration in plants.

Table 2: Percentage of Students with Misconceptions in Photosynthesis and Respiration in Plants

	Misconceptions in Photosynthesis and Respiration	n	% of Misconceptions
1.	Do plants take in gas?	124	96.1
2.	What is the benefit of photosynthesis to green plants?	71	55.0
3.	Why is Photosynthesis another forms of Respiration?	103	80
4.	What is plant's food?	111	86.2
5.	Why do animals respire and plants photosynthesize?	120	93.1
6.	When does respiration in plants only occur?	81	62.8
7.	Where does respiration in plants take place?	76	58.9
8.	What is the most important benefit of photosynthesis to plants?	98	76.0
9.	Respiration in plants occurs when?	102	79.1
10.	Do plants respire?	108	83.7

11.	What is the purpose of respiration in plants?	66	51.2
12.	Which of the following is plant's food?	81	62.8
13.	What are the similar characteristics of photosynthesis and respiration?	120	93.0
14.	Can plants respire?	119	92.2
15.	What is the similarity between photosynthesis and respiration in plant?	54	41.9

It would be observed in Table 2 that only in one item (item 15) did less than 41.9 percent of the students have misconceptions of Photosynthesis and Respiration in Plants in the TPR less than 50 percent. In three of the items (8, 2 and 11), the percentage of students with misconceptions of the concept of Photosynthesis and Respiration in Plants ranged between 51.2 and 79.1 percent. Generally, the results showed that in eleven of the fifteen items, all the student had misconceptions between 41.9 to 96.1 percent.

Research Hypothesis 1: There is no significant difference in the Refutational Texts Features of different textbooks used for teaching Photosynthesis and Respiration in Plants

Table 3: Summary of Mean Score and Standard Deviation of the Difference in Textbooks with RTF.

Textbooks	Mean	Std. Deviation
College Biology	4.30	2.28
Essential Biology	4.10	2.11
Modern Biology	4.33	2.51
Nelson Biology	3.80	1.67
Total	4.13	2.15

From Table 3, the results of the analysis revealed that Modern biology textbook showed the highest mean score of 4.33 with a standard deviation of 2.51; while the College biology showed a mean score of 4.30 with a standard deviation of 2.277. Essential Biology had the third high a mean score of 4.10 while Nelson biology had the lowest mean score of 3.80 with standard deviations of 2.107 and 1.669 respectively. The One-Way Analysis of Variance (ANOVA) was used to text if the observed differences in the mean scores were significant. The result is presented in Table 3.

Table 3: ANOVA for the Differences in Textbooks with RTF

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.400	3	1.800	0.385	.764
Within Groups	542.467	116	4.676		
Total	547.867	119			

From Table 3, the results show that there is no significant difference in the RTF of different textbooks used for teaching Photosynthesis and Respiration in Plants in secondary schools at 0.05 level of significance. The calculated F=value of 0.385 (df = 3,116) with p-value =764 which was not significant at 0.05. This means that there is no significant difference in the features of Refutational Texts available in the different textbooks on Photosynthesis and Respiration in Plants from. Therefore, the null hypothesis is retained.

Discussion of Findings

The finding for research question one showed that, from the rating of the texts on photosynthesis and respiration in plants by the students revealed that the four commonly used textbooks (College Biology, Essential Biology, Modern Biology and Nelson Biology) did not have the RTF in them. The students who rated the textbooks had the view that the four texts that each of them reads did not inform the students and teachers that students had misconceptions on photosynthesis and respiration in plants. This is inconsistent with Sunarmi and Sari, (2020) who opined that biology textbooks are often laden with diagram errors, misconceptions, inaccurate content presentation, curricular issues, and other forms of inaccuracies. The texts did not have features refuting misconceptions neither did the texts provide any scientific view on the topic of Photosynthesis and Respiration in Plants. The results support (Guzzetti *et al*., 1992) assertion which stated that textbooks typically contain very little refutation text characteristics. It can be inferred that the biology textbooks which were analyzed for this study for teaching biology are examples of expository texts were by authors of these texts write them with a purpose of informing the reader. In situations where an expository text presents counter-intuitive scientific information which may not be supported by reader's background knowledge, the use of refutation texts - the texts that acknowledge students' alternative conceptions and then explicitly refute them produces better understanding results than non-refutation texts (Broughton & Sinatra, 2010).

The finding from research questions two showed that a high majority of the students, with an average of 74.11 percent had misconceptions in all the test items over and above the (25.87%) of students with correct conceptions of the concept of Photosynthesis and Respiration

in plants. This result is consistent with those of Lim and Poo (2021), noted that it was important to stress that students' have several misconceptions in the concept of photosynthesis and respiration in plants. Most of the students' concentrate on the following misconceptions: "Photosynthesis is a gaseous exchange process during which CO_2 is taken in and O_2 is given off, while photosynthesis in plants is the taking in of CO_2 and giving off of O_2 during the day, it is taking in of O_2 and giving off of CO_2 at night; the most important benefit to green plants when they photosynthesized is giving off oxygen; Photosynthesis takes place mainly in the leaves, "Respiration occurs in no plants cells; Respiration in plants occurs only at night etc. These misconceptions may have stemmed from the biology textbooks rated for this study which the teachers and students used for the teaching and learning of the concept. The misconceptions identified in this study suggested that the authors of the selected biology textbooks paid little attention to basic qualities and expected misconceptions in biological concepts. Findings of this study were partially consistent with the results of earlier studies on biology textbook analysis which revealed that biology textbooks are often laden with inaccuracies such as misconceptions, content presentation, and curricular issues among others (Bhatti *et al*., 2015; Lestari & Zulyusri, 2021; Novitasari *et al*., 2019 and Raharjo *et al*., 2018

The results of research hypothesis one revealed that there is no significant difference in the RTF of different textbooks used for teaching the concept of Photosynthesis and Respiration in plants in secondary schools. Since it has been established that none of the texts informed teachers and students of misconceptions, most of the student raters were of the view that the four texts refuted misconceptions lowly. The implication of this result is that students will have difficulty in restructuring their prior knowledge with the new knowledge which can lead to poor academic performances in the topic of the concept of Photosynthesis and Respiration in plants. The Piagetian notions of accommodation and assimilation and a recognition of the importance of prior knowledge contributed to the development of Posner *et al*. (1982) influential model of conceptual change. They noted the four conditions that must be met if conceptual change is to occur: prior knowledge must be identified as inadequate to solve the problem (dissatisfying), new information must be understandable (intelligible), new information must be useful in solving the current problem (plausible), and new information must appear useful in solving future problems (fruitful).

Conclusion

Based on the findings of this study, it can be concluded that the Biology texts recommended for teaching biology in secondary schools in Oredo Local Government of Edo State do not reflect the Features of Refutational Texts. Refutational Text has been found to be one of the most effective teaching strategies for clearing misconceptions and improving understanding. The study has also revealed that Biology textbooks used in schools are therefore expository in nature. The authors of these books only seek to inform the learner and do not take into cognizance what the students already know. The implication of the continual use of Non

Refutational Texts like those reviewed in this study is that, the students will continue to have misconceptions on the concept of Photosynthesis and Respiration in plants. This will consequently translate into poor academic performances in their future examinations as observed in the high number of students that had misconceptions in this study.

Recommendations

From the conclusion, the following recommendations were made:

1. Students and teachers must be made to be aware that most of the biology texts that are available for learning and carrying out assignments are not sufficient for their study.
2. Teachers and science educators should source for alternatives for teaching other than relying solely on textbooks.
3. Teachers and science educators should plan their lesson in such a way that their lesson note can reflect Refutational Text Features.
4. Workshops and seminars can be organized by Educational Agencies for teachers and authors to make these Science texts, especially to address the likely misconceptions that students may come into the class room with, refute such misconceptions and provide the scientifically correct views.

References

Amir, R., & Tamir, P. (1990). *Detailed analysis of misconceptions as a basis for developing remedial instruction: The case of photosynthesis.* Paper presented at the Annual Meeting of the *American Educational Research Association.* Boston, MA, 16–20 April.

Anjarsari, P. (2018). The common science misconceptions in Indonesia junior high school students. *Journal of Science Education Research, 2*(1), 21–24. https://doi.org/10.21831/jser.v2i1.19329.

Bhatti, A. J., Jumani, N. B., & Bilal, M. (2015). Analysis of alignment between curriculum and biology textbook at secondary level in Punjab. *Pakistan Journal of Social Science, 3* (1), 261-272. https://www.bzu.edu.pk/PJSS/Vol 35No12015/PJSS-Vol35-No1-21.pdf.

Broughton, S.H., Sinatra, G. M., & Reynolds, R. E. (2010). *The Nature of the Refutation Text Effect: An Investigation of Attention Allocation.* Utah State University.

Candra, P. M., Mercuriani, I. S., Nugroho, E. D., & Vlorensius, V. (2020). The biological content accuracy of natural science textbooks for VIII grade. *Journal of Pendidikan Biologi Indonesia, 6*(1), 135-146. https://doi.org/10.22219/jpbi.v6i1 .10837.

Cullinane, A., & Liston, M. (2011). *Two-tier Multiple-Choice Questions (MCQs) – How effective are they: A pre-service teachers' perspective.* Paper presented at The International Organization for Science and Technology Education (IOSTE) Conference, NW Europe, 20–21 June.

Galvin, E., Simmie, E. M., & O'Grady, A. (2015). Identification of misconceptions in the teaching of Biology: A pedagogical cycle of recognition, reduction and removal. *Higher Education of Social Science*, *8*(2), 1–8.

Ganiyu, B., Aransiola O. M., Fuad A. & Alani C. (2021). Analysis of diagram errors in selected Nigerian secondary school practical biology textbooks. *Jurnal Bioedukatika, 9*(3) 189-196

Guzzetti, B. J., Snyder, T. E., & Glass, G. V. (1992). Promoting Conceptual Change in Science: Can Texts be Used Effectively? *Journal of Reading, 35*(8) 642-649.

Guzzetti B. J., Hynd C. R., Skeels S. A., & Williams W. O. (1995) Improving Physics Texts: Students Speak Out *Journal of Reading, 35* (8) 656-663.

Guzzetti, B., Williams,W., Skeels, S.,&Wu, S. (1997). Influence of text structure on learning counterintuitive physics concepts. *Journal of Research in Science Teaching, 34,* 701–719.

Jayanti, P., & Rahayu, Y. S. (2019). Comparative study: Misconceptions on photosynthesis and respiration concepts from past to the present. *Jurnal Penelitian Pendidikan Sains*, *9*(1), 1750-1755. https://doi.org/10.26740/jpps.v9n1.p1750-1755.

Köse, S. (2008). Diagnosing student misconceptions: Using drawings as a research method. *World Applied Sciences Journal*, *3*(2), 283–293.

Lestari, R., & Zulyusri, Z. (2021). Identification of material misconceptions in high school biology textbooks and their relationship with students' misconceptions. *Jurnal Pendidikan Biologi Dan Sains*, *6*(01), 01-11 https://doi.org/10.51673/penbios. v6i01.600.

Lim, H. L., & Poo, Y. P. (2021). A diagnosis of students' misconceptions of photosysthesis and plant respiration. *Asia Pacific Journal of Educators and Education, 36*(1), 155–176. https://doi.org/10.21315/apjee2021.36.1.9

Marmaroti, P., & Galanopoulou, D. (2007). Pupils' understanding of photosynthesis: A questionnaire for the simultaneous assessment of all aspects. *International Journal of Science Education, 28,* 383–403. https://doi.org/10.1080/09500690500277805

Nair, A. (2019, 2019). Class XI biology textbook fraught with factual errors. *The Times of India.*https://timesofindia.indiatimes.com/city/pune/class-xi-biology- textbook-fraught-with-factual- errors/articleshow/72191676.cms

Novitasari, C., Ramli, M., & Karyanto, P. (2019). Content analysis of misconceptions on bacteria in the biology textbook of high school. *Journal of Physics Conference Series, 1157* (2), 1-7. https://doi.org/10.1088/1742- 6596/1157/2/022076.

Posner, G. J., Strike, K. A., Hewson, P. W. and Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education, 66*, 211-227.

Raharjo, D., Ramli, M., & Rinanto, Y. (2018). Misconception protist in high school biology textbooks. *International Conference on Mathematics and Science Education of University of Pendidikan Indonesia 3,85-90*. http://science.conference.upi.edu/ proceeding/index.php/ICMScE/arti cle/view/154

Ramnarain, U., & Padayachee, K. (2015). A comparative analysis of South African life sciences and biology textbooks for inclusion of the nature of science. *South Africa Journal of Education, 35*(1), 1-8. https://doi.org/10.15700/2015030 62358

Sunarmi, S., & Sari, D. A. W. (2020). The biology high school text-book's errors on fern material. *AIP Conference Proceedings, 2215* (1), 030017. https://doi.org/10.1063/5.000057

Svandova, K. (2014). Secondary school students' misconceptions about photosynthesis and plant respiration: Preliminary results. *Eurasia Journal of Mathematics, Science & Technology Education, 10*(1), 59–67. https://doi.org/10.12973/eurasia.2014.1018a

Treagust, D. F., & Haslam, F. (1986). *Evaluating secondary students' misconceptions of photosynthesis and respiration in plants using a two-tier diagnostic instrument.* Paper presented at the 59th Annual Meeting of the National Association for Research in Science Teaching, San Francisco, CA, 28–31 March.

Vojíř, K., & Rusek, M. (2019). Science education textbook research trends: a systematic literature review. International *Journal of Science Education, 41*(11), 1496- 1516. https://doi.org/10.1080/09500693 .2019.1613584

West African Examinations, C. (2021). Biology WAEC. *elearning*. https://www.waeconline.org.ng/e- learning/Biology/Biomain.html