A Comparative Study of Textbook Readability and Students' Comprehension Levels in Senior Secondary School Biology

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Abstract

The study compared the textbook readability and students' comprehension level of Senior Secondary School Biology in Ekiti State, Nigeria. The study population consisted of all the Senior Secondary School 1-3 in Ekiti State. A sample of 108 (36 Senior Secondary one, 36 Senior Secondary two and 36 Senior Secondary three) students were randomly selected from six secondary schools using stratified random sampling technique. Two instruments were used for the study. These are: cloze procedures and Flesch reading ease formula. Findings showed that all the textbooks are quite difficult and far above the reading comprehension level of the students. It was suggested that text materials to be presented to these students should be written with reduced syllable and short sentence length that can be read with ease by the students.

Keywords: Flesch Reading Ease Formula, Cloze Test, Senior Secondary School, Biology Textbooks and Readability

1. Introduction

Biology is one of the compulsory science subjects that are taught in the Senior Secondary Class one to Class three because of its importance to the survival of living organisms. For students to cope with the numerous challenges of the subject there is need to provide them with materials written at the lowest readability level. However, majority of the students seem to encounter reading difficulty in many of the available Biology text materials; more so, that textbooks have been seen as the most important tools in the teaching of students (Baker, 2004). Several studies have shown that these texts are often too difficult for students (Baker, 2004; Ayodele, 2009; Yong, 2010 and Ayodele, 2012) most especially for students who learn science in a second language. This is also affirmed in the research conducted by Letsoalo (1996) and Doidge (1997) that language used in some African science textbooks is too advanced for many of the pupils.

Studies conducted by many researchers have also shown that materials supplied to most students are too difficult for them to read. For example, Heppner, Heppner and Leong (1997) studied the readability of biology materials and the reading ability of sixth form students (US 12th grade) in Brunei Darussalam and found that the reading materials supplied to the students were considerably more difficult than they were able to read comfortably. They found that about 10% of students have the readability level of US equivalent 12th grade while the majority of 90% have the depressingly low readability level of 9th grade (15%) and 7th grade (75%). In a similar research, Soyibo (1996) made comparison of three high-school biology textbooks used in the Caribbean Islands and found that the biology texts were difficult for the target students to read and understand.

Wright (2006) examined the effect of reducing reading difficulties by providing high school pupils with materials written at a lower level of readability than that of the assigned Modern Biology textbook, 5th ed. The subjects for the study were 265 ninth and tenth graders. Two chapters on genetics from the textbooks were re-written to a sixth grade level, new terms were explained as they

were introduced and then re-used shortly after. Wright found that for all students, the materials that had been re-written to a sixth grade level of readability were significantly easier to comprehend than the assigned Modern Biology textbooks. Re-writing portions of the Biology textbook to a sixth grade readability level using the researcher's guideline and Fry's readability graph proved to be a successful method of increasing student's comprehension of both technical and non-technical materials.

Abanami (1982) analyzed the readability level of the eleventh and twelfth grades Earth science textbooks used in the public schools in Saudi Arabia using multiple choice and Cloze tests on 157 eleventh and 152 twelfth grade students. The results showed that four percent of the eleventh graders tested were able to score 6% at the independent, 43% at the instructional and 51% at the frustration reading level. Thirty three percent of the twelfth graders scored 50% at the instructional reading level. This implies that, majority of the students seem to be encountering reading difficulty and need additional reading instruction in order to learn the material presented in their earth science textbook.

One major obstacle that is been face by many students is language of science. The language requires a careful and precise explanation in order to ensure a shared meaning between the participants in the classroom discourse. Communication in science relies heavily on cognitively demanding vocabulary which has been identified as being particularly difficult for learners to acquire (Cummins, 1984). The academic success of students in school subjects is strongly tied to fluent use of these vocabularies. Wellington and Osborne (2001) claimed that "Language is the major barrier (if not *the* major barrier) to most pupils in learning science". They reasoned that science has its own language and learning the language of science poses a major challenge to pupils. Rutherford (1993) made an important distinction by showing that the language of science is a language that transcends other language differences. Referring to the problem in studying science by Nigerian secondary school students, Ajeyalemi and Busari (1986) wrote that language difficulty (both technical and non-technical) and the confusion between language used at home and language of instruction and learning are major factors in students' underachievement in science.

The prevalent language crisis in the chemistry laboratory was also pointed out by Adesoji (2005) in which he argued strongly that non-comprehension of language of mathematics, language of chemistry and language of instruction (English language) was responsible for students' low achievement in chemistry.

To assure an appropriate match between the reading abilities of learners and the reading demands of their texts, teachers use a variety of formal and informal assessment instruments to determine students' instructional reading levels. Such instruments include a passage-completion technique known as the cloze procedure, Flesch Reading Ease formula, Fry's Readability Graph and many more. No matter the choice of the formula or graph, if the readability level of the textbook exceeds the selected grade level, such book is often not considered an appropriate choice for the students. Chiang-Soong and Yager (1993) asserted that for most readability graphs and formulae such as Flesch Reading Ease formula and Fry's Readability Graph derived their grade level by considering two factors: (a) word difficulty and (b) sentence complexity. Word difficulties are often referred to the number of syllables or words per sentence or per 100-word sample. Sentence complexity may be determined by the number of word per sentence and the number of words with five or more syllables.

2. Problem

Despite the researches conducted in Nigeria over the years, not many have actually dealt with the selection of the appropriate Biology textbooks for the students' use in schools. Data from Ekiti State Ministry of Education and Technology, Ado-Ekiti revealed that many candidates have been failing the subject over the years. For example, the analysis of the West Africa Examinations Council/Senior Secondary Certificate Examinations results of students in Biology in Ekiti State between 2004 and 2008 showed that 23% of the total students who registered for Biology in 2004 had credit pass. In 2005, it was 30.1% and by 2006 it was 53% while in 2007, it was 10% and 2008, it was 22%. These poor results could be attributed to many reasons ranging from poor teaching technique to the ease or

difficulty level of the text materials presented to the students. It is on this note that necessitated the need to ascertain whether the Essential Biology textbook used in most of the Senior Secondary Schools in Ekiti State is appropriate for the intended classes or not. On the basis of this, the following questions were raised to guide the study.

1. What is reading comprehension level of the students in Biology?
2. Are the books appropriate for the intended users?
3. What are the readability levels of the Biology textbooks used by the Senior Secondary School Students?
4. What are the grade levels of the selected Biology textbooks used by the Senior Secondary School students?

3. Purpose of the Study

The major purpose of the study was to determine whether the reading comprehension level of the students in biology as measured by cloze procedure are below, at average or above the readability levels of the required textbooks as measured by Flesch Readability Formula.

4. Method

108 students of the Senior Secondary School 1- 3 levels were involved in the study. A sample of 36 students from each level was selected from six Senior Secondary Schools in Ekiti State, Nigeria using stratified random sampling technique. The two instruments used for the study include Flesch Reading Ease Formula developed by Rudolph Flesch (1948) and cloze test developed by Wilson L. Taylor in 1956. The *Essential Biology for Senior Secondary Schools Book 1-3, written by Michael, M. (2011) and Published by Tonad publisher Limited, Ikeja, Lagos, pp. 39, 69 & 161 for book 1, pp. 19, 34 & 121 for book 2 and pp. 30, 121, & 186 for book 3* was also used. The data used for the study were collected directly from the selected textbooks and since the textbooks are standardized materials and recommended by the Government of Ekiti State for students used, it needed no revalidation. To find out whether the students would understand the written passage of the selected text materials, Flesch Readability Formula was used to determine the vocabulary loads of the selected passage by counting the number of syllables per word and the sentence length by counting the number of words per sentence. The formula involved selecting a sample of three 100-words, counting the number of sentence as well as syllables in each of the three 100-words. The passages used were selected from near the beginning, middle and towards the end of the textbooks and the Flesch Reading Ease Formula: FRE = 206.835 – (1.015 x ASL) - (84.6 x ASW) was applied. Where, ASL is the average sentence length (the number of word divided by the number of sentence), and ASW is the average number of syllables per word (the number of syllables divided by the number of words). In addition, the grade level of the textbooks was calculated using the following formula: (L x 0.39) + (N x 11.8) – 15.59 years.

The cloze tests with every fifth-word deletions from the sample passages were administered to the students to measure their reading comprehension level. In this procedure, words are deleted from the texts and readers are asked to fills in the appropriate or similar word in the passage. The ability of students to identify the missing word or to put in a satisfactory substitute for the original word indicates that reader comprehends the content of the text. The test was administered to selected students in Senior Secondary one to three during the normal class hours. To score the cloze passage, only the exact replacements were counted as correct answers. Spelling errors were not penalized. The raw score was the number of words that are correct and the correct numbers were double to find the percentage. These two instruments were used because they do provide the accurate assessment of the difficulty or the ease of text materials.

Table 1: Students' reading level in relation to cloze test and suitability of the text material.

Cloze scores	Reading Level	Description
60-100%	Independent	Material is too easy
40-59%	Instructional	Material is appropriate
0-39%	Frustration	Material is too difficult

Source: (Wellington and Osborne, 2001)

Flesch Readability Formula rating is based on 100-point scale, from 0-100, with 0 corresponding to the very difficult reading and 100 corresponding to the very easy reading. Table 3 provides interpretation of Flesch Reading Ease Scores.

Table 2: Flesch Reading Ease Score

Reading Ease Score	Description	Reading Grade
0 – 29	Very difficult	Post graduate grade
30 – 49	Difficult	College grade
50 - 59	Fairly difficult	10th-12th grade
60 - 69	Standard	8th-9th grade
70 - 79	Fairly easy	7th grade
80 - 89	Easy	5th-6th grade
90- 100	Very easy	4th-5th grade

Source: (Wyatt, and Schnelbach, 2008).

5. Results and Discussion

The questions raised for this study were subjected to descriptive analysis using frequency counts, percentages, cloze test scores and Readability scores.

Table 3: Numbers of students who read the text materials at independent, instructional and frustration levels based on the scores obtained in the cloze test

Textbooks	Cloze Reading Levels	Scores	Numbers of students	Remark
Book 1	Independent level	60-100%	09	Too Easy
	Instructional Level	40-59%	10	Appropriate
	Frustration Level	0-39%	17	Too Difficult
Book 2	Independent level	60-100%	10	Too Easy
	Instructional Level	40-59%	12	Appropriate
	Frustration Level	0-39%	14	Too Difficult
Book 3	Independent level	60-100%	07	Too Easy
	Instructional Level	40-59%	10	Appropriate
	Frustration Level	0-39%	19	Too Difficult
	Total		108	

The cloze data in table 3 indicated that 17 (47%) of the total sample of the students in the Senior Secondary one read the *Essential Biology book one* at a frustration level. This set of students experience serious difficulties in the course of reading the book as it could be seen that they score below 40% in cloze test. 10 students, about 28% of the total sample, found the book appropriate for reading as reflected in their scores, while only 9 students, about 25%, can read the book independently without the assistance of the teachers. A cursory look at this result showed that the book is written with a high readability level that is above the comprehension level of the Senior Secondary one students.

The table further showed that 14 students, about 39% of the total sample in Senior Secondary two, found *Essential Biology book two* extremely difficult to read as they score below 40% in the cloze test, these students also experience frustration in the course of reading the book. 12 students, representing 33% of the total sample in Senior Secondary two, could read the book with the assistance of the teachers while only 10 students, representing about 28%, could read the book with ease. Further analysis of the table also revealed that 19 students, about 53% of the total sample of students in Senior Secondary three, read *Essential Biology book three* at a frustration level, 10 students representing 28% read at instructional level while 7 students, representing 19%, read at independent level. Generally speaking, the *Essential Biology for Senior Secondary one to Senior Secondary three* were written above the reading comprehension level of the expected users.

Table 4: Readability data of the Essential Biology Textbooks showing the readability scores and the grade levels using Flesch Readability Formula.

Textbook	Readability Scores	ASL	ASW	Grade Level	Remark
SS One	45.1	19.03	142.70	12th	Difficult
SS Two	59.2	19.03	128.60	10th	Fairly Difficult
SS Three	43.3	16.90	146.60	12th	Difficult

The use of Flesch Reading Ease Formula in table 4 showed that the *Essential Biology for Senior Secondary one to Senior Secondary three* attracted high reading demand that is above the reading ability of the students. The readability scores of 45.1, 59.2 and 43.3 obtained for books one; two and three respectively indicated that the textbooks are difficult for the students. The average syllable per word in the passage selected in book one (142.70), book two (128.0) and book three (146.60) is an evidence that the books contained too many polysyllabic words than what the students can understand. The formula also showed that the grade level obtained for each of the book were 12th grade for book 1, 10th grade for book 2 and 12th grade for book 3. The advocates of readability formulas advised that readers who speak English Language as Second language (ESL) like Nigerian child should be place at least a year behind his American counterpart because of the differences in the reading ability of ESL readers and those who speak the language as First Language. Going by this assumption, the grade level of 12th for book one, 10th for book two and 12th for book three as reflected in table 4 will be adjusted by one to 13th for book one, 12th for book two and 13th grade level for book three respectively. The result suggests that an average student in Senior Secondary one to three will find the Essential Biology books one to three difficult to read and understand because the books are more of higher grades than the grade of the intended users.

Generally speaking, the difficulty level of the books could be attributed to the long word-length per sentence in the textbooks couple with polysyllabic words. For example, in the *Essential Biology book one*, 100-word sample under 'Law of Thermodynamics' revealed that there are three 16-words sentences, one 27-words sentence and one 28-words sentence, in *Essential Biology for Senior Secondary two,* 100-words sample under 'Haemolysis' there are one 27-words sentence, one 32-words sentence, one 25-words sentence and one 17-words sentence while in *Essential Biology for Senior Secondary three,* 100-words sample under 'Oviparity and Viviparity' there are one 16-words sentence, one 20-words sentence, two 14-words sentences and two 18-words sentences. All these could responsible for the complexity experience by the students in the course of reading the textbooks.

6. Conclusion and Recommendations

From the findings, it was revealed that all the textbooks are somewhat complex and far above the

reading comprehension level of the intended readers. It was also recorded that a vast number of the students are reading with frustration. This suggests that the Biology textbooks presented to all the students in Senior Secondary 1-3 are fairly difficult and not appropriate for them. It is therefore recommended that text materials to be presented to these students should be written with reduced syllable and short sentence length that can be read with ease by the students.

References

Abanami, A. A. (1982). Readability Analysis of the 11th and 12th Grade Earth Science Textbooks used in the Public Schools in Saudi Arabia. Unpublished PhD Thesis. University of Houston. S. A.

Adesoji, F. A. (2005). Language Conflict in the Chemistry Laboratory: The Nigeria Experience. The 5th Comparative Education Society of Asia Biennial Conference. May 30-31.

Ajeyalemi, D. and Busari, O. (1986). Factor Associated with Underachievement in O' Level Chemistry: An Investigation into Classroom Processes, Examination Performance and teacher and Pupils Opinions. Paper Presented at the 27th Annual Conference of the Science Teachers Association of Nigeria in Owerri, Imo State, Nigeria.

Ayodele, M. O. (2009). The Effect of Students' Reading Ability on Achievement in Integrated Science in Ekiti State. Journal of Educational Research and Development, 4, 3. A Journal of the Faculty of Education, Ahmadu Bello University, Zaria, 178-183.

Ayodele, M. O. (2012). Readability of Basic Science and Technology for Primary Schools. Research Journal in Organizational Psychology and Educational Studies 1, 1, 33-36, January, 2012.

Backer, P. (2004). "Reading in Science" Mathematics and Science Teacher Education Program. Teacher's Support Network.

Chiang-Soong, B and Yager, R. E. (1993). Readability Levels of the science Textbooks Mostly Used in Secondary Schools. School Science and Mathematics, 93, 24-27, January, 1993.

Cummins, J. (1984). Wanted: A Theoretical Framework for Relating Language Proficiency to Academic Achievement among Bilingual Students. In C. Rivera (Ed): Language Proficiency and Academic Achievement. Clevedon: Multilingual Matters.

Doidge, M. (1997). How Readable is your Biology Textbook? Can you be sure? Proceedings of the Fifth Annual Meeting of the Southern African Association for research in Science and Mathematics Education. Johannesburg, South Africa, 396-400.

Ekiti State Ministry of Education and Technology, (2010). Research and Statistic Department. Ado-Ekiti.

Flesch, R. F. (1948). A New Readability Yardstick. Journal of Applied Psychology. 32. 221-233.

Heppner, F. H., Heppner, M. C. & Leong, Y. P. (1997). Teachers' estimate of, and measurements of students' reading ability, and readability of text materials in English as a second language secondary Biology course. Journal of Applied Research in Education, 1(2), 31-39.

Letsoalo, M. B. (1996). Improving Text for English Second Language Biology Pupils. Journal of Biological Education. 30, 3, 184-186.

Michael, M. C. (2011). Essential Biology for Senior Secondary Schools Book 1-3. Tonad Publishers Limited, Ikeja, Lagos

Rutherford, M. (1993, June). Making scientific language accessible to science learners. Paper presented at the first Annual meeting of the Southern African Association for Research in Mathematics and Science Education, Grahamstown, South Africa.

Soyibo, K. (1996). A comparison of communication strategies among three Carribbean high-school biology textbooks. Journal of Biological Education, 30(3), 190-194.

Taylor, W. (1956). Recent Developments in the use of "Cloze Procedure." Journalism Quarterly, 33, (1), 42-48, 99.

Wellington, J and Osborne, J. (2001). Language and Literacy and Science Education. Buckingham, England: Open University Press.

Wright, J. D. (2006). The Effect of Reduced Readability Text Materials on Comprehension and Biology Achievement. Science Education, 66, 1, 3-13

Wyatt, E. S. and Schnelbach, S. D. (2008). Calculating Reading and Writing Levels. Tameri Guide for Writers. www.Amazon.Com.

Yong, B. C. S. (2010). Can Students Read Secondary Science Textbooks Comfortably? Brunei International Journal of Science and Mathematics Education, 2, 1, 59-67.