International Journal of Science and Technology (STECH)
Bahir Dar- Ethiopia
Vol. 7 (1), S/No15, February, 2018: 81-91
ISSN: 2225-8590 (Print) ISSN 2227-5452 (Online)
DOI: http://dx.doi.org/10.4314/stech.v7i1.7

INVESTIGATING THE ADEQUACY OF PHYSICS TEXTBOOKS USED IN NIGERIA SECONDARY SCHOOLS FOR CONCEPTUAL UNDERSTANDING WITH NEW PHYSICS CURRICULUM IN VIEW

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ABSTRACT

This study investigated the adequacy of the physics textbooks in use in Senior Secondary Schools in Nigeria using Owerri municipal as case study. Five research questions guided the study. The sampled textual materials were the three recommended physics textbooks. Twenty six physics teachers from ten public secondary schools in Owerri municipal, Imo State were used. The evaluation of these text books were carried out using the 8 – point quantitative approach to content evaluation of science text books (QACEST) and teacher's perception rating scales (TPRS). The 8 – point QACEST was used to answer research questions 1 to 4 while research question 5 was answered using teacher's perception rating scale The result

revealed that while all the text books were adequate in terms of content and study questions inadequacies exist in some of the texts in the areas of learning activities, illustrations and teacher's perception. This simply implies that no single text books have completely met the requirements of the new physics curriculum. However, teachers should not adhere to a particular text book but rather should expose their student to a variety of text books depending on the goal or aim of the lessons.

Key word: Investigating, Adequacy, Text book, conceptual understanding

INTRODUCTION

Physics is a key subject to economic, scientific and technological development (American Physics Society, 2008). An alternative name to physics is technology and development. This is because any meaningful development that would come up through technology must be physics based (Kuti 2006, Chukwunenye 2014). The importance of physics to the society today is evident in man's reliance on technology. Other disciplines such as chemistry, geography, oceanography, seismology, medicine, astronomy and many other disciplines are examples of areas that depend either directly or indirectly on the knowledge of physics. Physics-based technologies that have revolutionized the world today are cell phone, internet, computers, and motorized equipment. In other words, physics could be used as the indices for development of any country. This implies that, what you do with physics could determine the level of attainment for any nation in terms of development. Considering the indispensable nature of physics in the technological world that we live in today, it is expected that priority would be given to the teaching and learning of physics to enhance productivity of every nation but unfortunately, many nations especially sub Saharan Africa do not consider physics as a school subject to reckon with and hence had remained technologically backward.

Reports have shown that the performance of students from 2011 to 2015 in WASSCE examinations in physics is not encouraging. Data from the West African Examination Council revealed that the failure rate for Biology and Chemistry was 42.19% and 48.79% respectively while the failure rate for physics for the years indicated was 48.28%. (This is very close to 50% of the entire population that sat for physics examination, this calls for attention of all stakeholders in physics education). The pertinent question should be "what went wrong"?

Since any nation cannot develop beyond its educational level of attainment, many reforms had been carried out in science education on both global and national level from the time of Nigeria independence to the present. Many documents on the various reforms had been produced from the time of Lord Lugard educational ordinance of 1916 (Igbokwe 2015). This educational ordinance opened the avenue for western education in 1842 with the coming of missionaries in Nigeria. However, attention was not given to the development of science education. In 1963, under a cooperative agreement, of Comparative Education, Study and Adaption Centre (CESAC), Science Teachers Association of Nigeria (STAN) and other bodies drawn from both universities and ministry of education produced the first set of indigenous syllabi in physics, chemistry, biology and integrated science (Okpala2015). Since then many curriculum reforms has been initiated and executed.

The nine year basic education curriculum which was recently revised in 2012 and implementation commenced in 2014 emphasized the importance of science education. The revision was focused on the structure, special features and the implementation strategy. The emphasis is on basic science and technological component of the curriculum (Igbokwe 2015).Attention was also focused on the need to encourage the use of text books which promotes innovative teaching and learning in order to promote a holistic approach to science

teaching. This was done by identifying and remitting repetition or duplication of concepts. The essence is to be in compliance with national and global issues without necessarily overloading the content (Adeyemo 2010). With the aim of arresting the interest of young creative minds towards scientific attitude hence, making the young learner to love not just science but process of science that could create change in their society.

Dike (2014) posited that is not enough to produce curriculum document but it is most important to ensure that the document produce a realizable, thorough and effective, for classroom teaching and practices. The Nigerian Educational Research and Development Council (NERDC) developed a new curriculum for all secondary school subjects' including physics. This new curriculum became operational in 2011 with the same objective as the 2008 edition but different structure. The aims of the new curriculum are:

- To provide basic literacy in physics for functional living in society
- To acquire basic concepts and principles of physics as a preparation for further studies
- To acquire essential skills and attitude as a preparation for technological application of physics
- To stimulate and enhance creativity

The structure of the new curriculum is thematic in approach. More related topics were added to the existing ones while some entirely new theme like physics in technology was introduced. However, if this new curriculum must have the desired impact, the textbooks to be used must be revised to match the curriculum. Textbooks are curriculum materials that play major role in curriculum implementation. In the developing nations, teachers and learners are handicapped without the textbook, more so when there are shortage of qualified teachers and limited access to online materials. It became expedient to ensure that the textual materials needed to drive home the blue print specified by the curriculum planners is in place and in standard and acceptable form.

In the Nigeria Society, especially for secondary school education, textbooks are the most fundamental curriculum material and source of information on which the learner builds. Hence, the textbook to a very large extent determine the quality of teaching and learning that would take place. This is so because it represents 90% of the material available for consultation by both teacher and learner especially in many developing countries.

Promoting students' conceptual understanding has been the focus in science education and physics in particular. According to Duit and Treagust (2003) the foundation for educational reform is based on the fact that students come to the class with already formed conception. The ability of the teacher to change these conceptions either by accommodation or subsumption theory in the teaching and learning process is very germane. Subsumption theory is a theory that connects new skills or learning into the large scope of past experiences. David Ausubel the theorist propounded that the ability to connect the previously established information to newly established information, is made possible through assimilation or accommodation. Assimilation occurs when new information is related to an existing relevant aspect of individual's knowledge structure. In this case subsumption becomes easy otherwise the learner devises a means of accommodating the information which may result to misconception. Some of this conception as wrong as they are, exhibit a well-developed thinking structure frequently grounded in everyday life's experiences. This misconception usually originates from students' interaction and experiences with the real world. The source of students' misconception could sometimes be the teacher who themselves could exhibit

similar alternative conception and reflect this in their teaching as a result of poor academic background especially when such teacher is armed with textbooks that are deficient in some areas with inadequate analogies and models.

Textbook has been reported to be another major source of misconception in learning to both teacher and learner. A textbook that does not support the curriculum content is thus counter-productive as it will probably interfere with the students' ability to attain the objectives of that curriculum. There is therefore great need to periodically evaluate the physics textbooks in use in our secondary schools to determine their conformity to the new physics curriculum. It is therefore against this background that the researcher embarked on investigating the adequacy of physics textbooks used in Nigeria secondary schools for conceptual understanding with the new physics curriculum in view.

STATEMENT OF THE PROBLEM

The performance of students in external examinations in physics in Nigeria secondary school is not encouraging. Since these examinations are in standardized form, it involves comprehensive testing system at different stages. External examination bodies take part in planning the curriculum for uniformity of purpose, aims and objectives. Another body sets examinations that assess the attainment of the curriculum content and students are assessed by public examination bodies. Since textbooks are currently the major source of information for preparation towards this examinations and also a means to enhance the conceptual understanding of the learner. (It becomes expedient to evaluate textbooks by eliciting information that can be used for diagnosis of textual materials to see). Is the standard of such materials adequate to prepare the learner towards understanding of the concepts as contained in the curriculum or are such textbooks counterproductive.

RESEARCH QUESTIONS

The following research question guided the study;

1. To what extent does the content of physics textbooks in use in senior secondary schools reflect the content of the new physics curriculum?
2. How adequate are the learning activities of the physics textbooks in senior secondary schools?
3. How adequate are the study questions contained in the physics textbooks for senior secondary school physics?
4. To what extent does the illustrations contained in the physics textbooks adequately represent the content of the new physics curriculum?
5. What are the teachers' perceptions of the physics textbooks in terms of compliance with the new physics curriculum?

METHOD

Research Design: Descriptive survey research design was adopted for this study. This is because descriptive survey research design aims at collection data and description in a systematic manner the characteristics features of a given population. The design was found useful because the study involved collection of data on features of physics textbooks and systematically describing these features as contained in the respective textual materials. The use of a structured questionnaire was employed to elicit responses from the teachers on the level of textbooks compliance with the new curriculum.

The study covered three of the physics textbooks approved and recommended by the Federal Ministry of Education in Nigeria which are used in teaching and learning physics at senior

secondary school level. The three textbooks are: *New School Physics* by M. W. Anyakoha, *Senior Secondary School Physics* by P. N. Okeke and M. W. Anyakoha, *Essential Physics* by O.E Farinde, H. E. Ehimetor and S. K. Dada. The study also covered Owerri municipal council area of Imo State. Physics teachers in government owned Secondary Schools constituted the respondents.

Population and Sampling: The population of the study in this case is five physics textbooks approved and recommended by the Ministry of Education and the twenty six physics teachers of the ten (10) government owned secondary schools in Owerri municipal of Imo State. The five recommended physics textbooks are:

i. *New School Physics* by M. W. Anyakoha
ii. *Principle of Physics for Senior Secondary School* by M.N Nelkon
iii. *Senior Secondary Physics* by P. N. Okeke and M.W. Anyakoha
iv. *Essential Physics* by O. E. Farinde, H. E. Ehimetor and S. K. Dada
v. *STAN Physics* for Senior Secondary School

The sample for the study comprised of all physics teachers in all the ten public secondary schools in Owerri municipal. Also three physics textbooks were drawn through purposive sampling from five recommended physics textbook. This was because the researcher wanted to evaluate the physics textbooks that are commonly used in senior secondary schools in the area. The textbooks that were purposively sampled were:

i. *New School Physics* by M.W. Anyakoha. 2015. 4th edition
ii. *Senior Secondary Physics* by P. N. Okeke and M.W. Anyakoha 2011. Revised edition
iii. *Essential Physics* by O. E. Farinde, Ehimetor, H. E., and S. K. Dada 2015. 3rd edition

The population of the physics teachers in each school of the population was small therefore; the schools and the teachers were not sampled.

Research Instruments: The instruments used to collect data for the study were

i. Questionnaire on teachers perceptual index of the text book conformity to the said curriculum (TPI)

ii. 8 – point quantitative approach to content evaluation of science textbooks (QACEST)

The 8 – Point Quantitative Evaluation Model for Science Textbooks as instrument was developed by Emerole (2008). It is an update of the 5 – point quantitative approach for content evaluation of textbooks (QACEST) developed by Nworgu (2001). It uses eight criteria in evaluating science textbooks; which are: Topical coverage index (TCI), learning activity index (LAI), study questions index (SQI), illustration index (ILI), chapter summary index (CSI), under-represented population index (UPI), readability and comprehensibility index (RCI), and teachers perceptual index (TPI). This instrument was adapted by the researcher for this study. Five out of the eight sub-sections were used. The aspects of the instrument used were:

i. **Topical Coverage Index (TCI):** This provides an estimate of how far the content of the textbooks covers the prescribed topic in the syllabus

ii. **Illustration Index (ILI):** This provides an estimate of the degree to which the textbook makes for better and more meaningful understanding of the ideas being referred to in the textual material

iii. **Learning Activity Index (LAI):** Is used to estimate the degree to which the textbooks provides activities that will enhance level of participation of the learners as specified by the curriculum.

iv. **Study Questions Index (SQI):** This is used to provide an estimate of the extent to which the study questions in the textual material challenges the learner meaningfully.

v. **Teachers Perceptual Index (TPI):** This is used to provide estimate on the teachers' perception of the extent to which a textbook reflects the specifications of the curriculum

Questionnaire on Teachers' Perceptual Index (TPI): This is 20-items questionnaire designed by the researcher, TPI is one of the sub-section of the 8-point quantitative evaluation model (QACEST) updated by Emerole (2008) from 5-point quantitative approach designed by Nworgu (2001). The first four subsections of the instrument were used unaltered, while the last one (teachers' perceptual rating scale (TPRS) is usually developed by the researcher. This is in line with the recommendation of Emerole (2008) that the teachers perceptual index (TPI) though an aspect of the 8-point QACEST should be determined using instrument designed by the researchers in order to reflect the nature of the subject (Physics, chemistry, biology etc. or students' characteristics). The TPI consist of two sections; section A which identifies the code given to each subject and section B consisting of twenty (20) items drawn from the specification of new physics curriculum soliciting for teachers' opinion on each textbooks' conformity to the said curriculum.

Validation of Instrument: The instrument was adapted from 8-point quantitative approach developed by Emerole and Ramiki (2008). This instrument has been used extensively by other researchers and the validity of the instrument is known to be 0.91. The researcher revalidated this instrument by administering the modified form of it to some Senior Secondary School teachers that were not part of the study sample using inter-rater reliability procedure. This was necessary as the assistance of physics educators was employed to individually score the test books using specification given by the instrument Quantitative Approach Content Evaluation of Science Textbooks (QACEST). The reliability indices of 0.93, 0.90 and 0.95 were obtained for the three textbooks respectively. The overall reliability estimate obtained for the instrument was 0.91 which is an indication that the validity and reliability is high enough for the study.

Investigation Procedure: The instrument was administered based on the evaluation procedure recommended in QACEST manual as follows:

Topical Coverage Index (TCI)

$$TCI = \tfrac{1}{2}\left[\frac{T_t + S_t}{T_s S_s}\right]$$

Where T_t = Number of topics sufficiently covered by the textbook

T_s = Number of topics sufficiently covered by the syllabus

S_t = Number of sub-topics sufficiently covered by the textbooks

S_s = Number of sub-topics in the syllabus

Where = Maximum value = 1
Minimum value = 0

Acceptable range is 0.80 – 1.00

ADEQUACY OF LEARNING ACTIVITIES

This was calculated using learning activities index (LAI) formular

$$LAI = \frac{A - P}{A + P}$$

Where A = Number of textbook topics containing activities for the learners to perform

P = Number of textbook topics requiring the learner to only receive information with no other activity

The LAI value ranges from + 1 to -1

+1 = Indicated that all topics included activities for the learners to carry out
-1 = Indicated that all topics has no provision for activities in the text
Acceptable value for LAI = 0.80 – 1.00

ADEQUACY OF STUDY QUESTIONS

This was calculated using study questions Index (SQI) formula.

$$SQI = \frac{T - R}{T + R}$$

Where T = Number of questions that require the learners to engage in real thinking

R = Number of questions that require learners to merely recall knowledge

The range for SQI is from +1 to -1. The maximum value of +1 is an indication that study questions are of higher order while -1 is an indication that study questions are of lower order. The ideal value is 0.60. The range of accepted value is within 0.50 – 70

ADEQUACY OF ILLUSTRATION INDEX

This was calculated using the illustration index (ILI) formula,

$$ILI = \frac{L_a - L_b}{L_a + L_b}$$

Where L_a= Number of large, clear, well captioned, labeled illustrations in the textbook

L_b = Number of unclear, shaded, ill-labeled, clumsy and uncaptioned illustrations in the textbook.

The value ranges from -1 to +1. A value of -1 indicated that all illustration provided where not explicit enough but shaded, ill-labeled or uncaptioned whereas +1 is an indication that all illustrations in the text are good, clear, well-labeled and captioned. The ideal value is 1.00 but the acceptable value is within 8.00 to 1.00

The fifth research question was answered using responses from a four pointlikert scale questionnaire. These responses were analyzed using mean value.

RESULTS

Research Question 1: To what extent does the content of physics textbooks in use in the senior secondary schools reflect the contents specified in the new physics curriculum?

Table 1: Topical Coverage Index (TCI) of physics textbooks in use in senior secondary schools

S/No	Textbook	T_t	T_s	S_t	S_s	Index	Decision
1	New School Physics (NSP)	57	62	303	316	0.94	Adequate
2	Essential Physics (EP)	53	62	255	316	0.83	Adequate
3	Senior Secondary School Physics (SSSP)	52	62	297	316	0.89	Adequate

Acceptance range 0.80 – 1.00

The result from table 1.0 revealed that all the text books evaluated are within the acceptable range of topical coverage index.NSP is highest with 0.94, followed by SSSP with 0.89 and the least was EP with 0.83

Research Question 2: How adequate are learning activities of the physics textbooks in use in senior secondary schools?

Table 2: Learning Activities Indices of physics textbooks in use in senior secondary schools

S/No	Textbook	A	P	Index	Interpretation
1	New School Physics (NSP)	48	09	0.84	Adequate
2	Essential Physics (EP)	49	03	-1.00	No Learning activities
3	Senior Secondary School Physics (SSSP)	00	53	0.88	Adequate

The result from table 2 showed that two of the physics textbooks have learning activities and indices fall within the acceptable range 0.88 for SSSP and 0.84 for NSP. The third textbook (EP) was found to have no learning activity at all.

Table 3: Study Questions Indices (SQI) of Physics Textbooks in Use in Senior Secondary Schools in Owerri Municipal

S/N	Textbook	A	P	Index	Interpretation
1.	New School Physics (NSP)	365	75	0.66	Adequate
2.	Essential Physics (EP)	427	103	0.61	Adequate
3.	Senior Secondary School Physics (SSSP)	375	108	0.57	Adequate

Research Question 3: How adequate are the study questions of the physics textbooks in use in senior secondary schools?

Acceptable range: 0.50 – 0.70

The results presented on table 3 showed that all the textbooks evaluated have acceptable range of study questions; NSP has 0.66, SSSP has 0.61 while ESP has 0.57 respectively.

Research Questions 4: To what extent does the illustrations contained in the physics textbook adequately represents the content of the curriculum?

Table 4: Illustration Indices of Physics Textbooks in Use in Senior Secondary Schools in Owerri Municipal

S/No	Textbook	L_a	L_b	Index	Interpretation
1	New School Physics (NSP)	169	08	0.91	Adequate
2	Essential Physics (EP)	92	22	0.61	Inadequate
3	Senior Secondary School Physics (SSSP)	121	21	0.72	Inadequate

Acceptable range = 0.80 – 1.00

Result from table 4 indicated that all the textbooks has inadequate Illustration Indices except New School Physics (NSP) with the Illustration Index of 0.91

Research Question 5: What are teachers' perceptions of the physics textbooks in use in senior secondary schools in terms of compliance with the new physics curriculum?

Table 5: Teachers' Perception Index (TPI)

	Items	Teachers mean perception		
		New School Physics (NSP)	Essential Physics (EP)	Senior Secondary School Physics (SSSP)
Grand Mean	EX	25.14	17.81	23.96
	$\bar{X}$	3.25	2.23	2.99

Acceptable range = 2.50 to 4.00

Result showed that data obtained from teachers perceptual rating scale (TPRS) which was used to determine the teachers' perceptual index (TPI) showed that only New School Physics (NSP) and Senior Secondary School Physics (SSSP) obtained the acceptable grand mean of 3.25 and 2.99 respectively

DISCUSSION OF FINDINGS

Findings revealed that the three textbooks were adequate terms in topical coverage, and study questions. This implies that these textbooks adequately covered the contents as specified in the new physics curriculum and included a good ratio of study questions as recommended by Bloom taxonomy of educational objectives in term of higher or lower order questions. However, in learning activities it was revealed that only two textbooks were adequate in this regards. These textbooks were *New School Physics* (NSP) by Anyakoha and *Senior Secondary School Physics* (SSSP) by P. N. Okeke and Anyakoha while in Essential Physics (EP) learning activities were inadequately represented. This further showed that these textbooks do not encourage student-centered activities or learning by doing which is the approach as specified by new physics curriculum. Therefore any teacher that decided to use Essential Physics would have to introduce the students to other physics textbooks that has adequate learning activities that would encourage a learner, centered approach to teaching which would enhance conceptual understanding.

Investigating the appropriateness of illustrations in these textbooks using Illustration Index (ILI), it was revealed that only New School Physics (NSP) contained adequate illustrations while New School Physics (NSP) was enriched with large, clear, colourful, well labeled and

captioned visuals which helped to capture the interest of the learner. The essence of very good illustrations in learning cannot be over emphasized. This is because good illustration provided in the textbook help the teacher to drive home points during classroom activities. In individualized learning, it also assist the student by bringing in some cues, and prompt which otherwise would make learning to become abstract and misconception is introduced. Hence the learner could become more confused without adequate illustrations. For Senior Secondary School Physics (SSSP) and Essential Physics (EP) both of them have heavily painted, shaded, ill-labeled and uncaptioned or sketchy drawing which could end up confusing the learner.

From the teachers perception which was obtained using Teachers' Perceptual Index (TPI) it was revealed that each of the textbooks on the average adequately complied with the specification of the curriculum in the area of content coverage, illustrations, study questions, adequacy of learning activities except for Essential Physics (EP) which did not meet up with the mean acceptable range. It could be inferred from this report that most teachers use either New School Physics (NSP) or Senior Secondary School Physics (SSSP) which could be the reason for their high rating. But this research revealed that Essential Physics (EP) is not very good in providing adequate illustrations for the concept or theme that is being taught. This was not reflected in the teachers' perception. It could be inferred from the teachers' response that the classroom teacher has a problem in selection of the appropriate textbook for appropriate task.

CONCLUSION

The study had shown that no single textbook is adequate for the teaching and learning of physics. Therefore, teachers should not adhere to a particular textbook but rather should be expose to a variety of textbooks depending on what sub-topic or theme they want to teach or the instructional objectives that they want to achieve during a lesson. However, some textbooks are better than the others because some were either inadequate in terms of learning activities or illustration or completely failed to include some of these content indicators in the textual materials.

RECOMMENDATIONS

There is need for proper evaluation of textbooks before such books are recommended for use in schools. This will help to check the introduction of textual material that would further confuse the learner nor provide opportunities for activities based learning. This situation could impede or pose as obstacle for conceptual understanding by the learner.

Teacher must be exposed to the essence of using more than one textbook in the class to achieve different purposes through workshops.

The National Education and Research Development Council (NERDC) with other curriculum development bodies should organize workshops for science teachers and textbook authors on how to produce high quality textbooks and the need for constant review of textbooks.

This study should be replicated in other areas of science such as Biology, Chemistry, Mathematics and many others.

Selection and recommendation of physics and other science textbooks should be carried out by professionals and other stakeholders such as Science Teachers Association of Nigeria (STAN), curriculum organizations and many other bodies should be involved

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