

Impact of Metacognitive Strategies of Textbook Reading on Students' Learning of Physics in Secondary Schools

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Abstract: *This paper investigated the impact of metacognitive strategies of reading textbook on students' learning of Physics in Secondary Schools in Ekiti State, Nigeria. This was a descriptive survey research which was questionnaire based. The population of the study was all public Secondary Schools (Senior Secondary class 2 Physics students) in Ikere Local Government Area of Ekiti State, Nigeria. Stratified random sampling technique was used to select twenty (20) Physics students each from the five (5) selected Schools of the study. A total of One hundred (100) Senior Secondary class 2 Physics students were used as samples for the study, these comprise of sixty eight (68) male and thirty two (32) female. Three research questions were generated and were tested at 0.05 level of significance. Among others, the study revealed that; Most Physics students in Secondary Schools in Ekiti State do not applied meta cognitive strategies while reading Physics textbooks before, during and after reading. Conclusion and recommendations were also made in this paper.*

Keywords: Meta cognitive strategies, Reading, learning, Physics students, and academic achievement

1. Introduction

The contemporary world is driven by science and technology which are interrelated. Science probes into the question "Why?" while technology probes into the "How?" aspect [15]. Science has become such an indispensable tool that no nation, developed or developing, wishing to progress in the socio-economic sphere will afford to relegate the learning of science in schools to the background. Science is the theory upon which the technology is built, without Science; there cannot be intuition for technology [17]. Physics is among the major pillar of science. Physics deals with the study of laws that determine the structure of the universe with reference to the matter and energy in the universe [11]. In the words of [20] "Physics is the most utilized basic science subjects in most technology and technology- related profession". This merely indicates that the enormous role Physics plays in the technological growth of any nation must not be undermined. It is germane to say that the technological growth of a nation leads to its social and economic development. The importance of Physics for the development of a nation is, therefore, glaring. Physics is the most basic of science and its concepts and techniques underpin the understanding of other disciplines: A thorough understanding of mechanics is necessary to chemists and material scientists since the structure of every atom in the universe is determined by mechanics. Physics is also a cross-cutting discipline that has applications in many sectors of economic development, including health, agriculture, water energy and information technology [15]. The understanding of Physics is quite necessary for developing new instrumentation and techniques in the health sector with the help of medical Physics, the right equipment for the diagnosis of diseases and the efficient communication of medical data are acquired. For instance, the Computed Tomography (CT) scanner is a hub for the development of telemedicine. The development of any nation, which depends on science and technology, hinges on the nation's science education. In

Nigeria, in spite of the enormous role (importance) that Physics provides for national development and efforts of government and other stake holders in improving science education, Physics results in most certified examinations like the West African Senior School Certificate Examination (WASSCE) and National Examination Council (NECO) have not been satisfactory. The broad aims and expectations of any teaching and learning programme is productivity and positive-evaluated end-product (achievement). But in recent times, Observations on students academic performance in science generally, and Physics, in particular over the years in the results of Senior Secondary Certificate Examination (SSCE) conducted by West African Examination (WAEC) and National Examination Council (NECO) revealed that a very few number of students perform better in Physics examination compared with other subjects. Parents and government are in total agreement that their huge investment on education is not yielding the desired dividend and that despite their hug investment on education, students' performances still remain poor. Teachers, also complain of students low performance at both internal and external examinations [29]. In particular, reports on WAEC results of Senior Secondary School Certificate Examination in Ekiti State over the years often revealed low performance of students in Physics. A summary of students' performance in Physics at WAEC from 2005-2012 are as given below:

Table 1: Summary of WAEC results in Physics in Ekiti State

Year	No Registered	A1- C6	D7- D8	F9
2005	3738	2156 (57.7%)	1104(29.5%)	478 (12.8%)
2006	4157	2661 (64.0%)	1004 (42.2%)	492 (11.8%)
2007	4435	2524 (56.9%)	1243 (28.0%)	668 (15.1%)
2008	3385	1274 (37.6%)	797 (23.5%)	1314 (38.9%)
2009	4289	2296 (53.5%)	1036 (28.7%)	937 (17.8%)
2010	5459	2569 (49.8%)	1825 (31.6%)	1065 (18.6%)
2011	6859	4020 (58.6%)	1124 (16.4%)	1715 (25.0%)
2012	5081	2514 (49.5%)	1379 (27.1%)	1188 (23.4%)

Source: [28]

A cursory look at table 1 shows that not very many of the candidates had credit pass in the subject over the period of observation. This shows that the level of performance is not good enough. [1], [6],[19], [18], [5], [2], [21], [4], [3] and [10] in their different studies discovered that poor academic performance and low enrolment in science generally, and Physics, in particular in Nigeria are caused by : poor reading habit, text readability problem, ineffective teaching methodology, negative students attitude/interest towards physics, school location, gender inequalities, inadequate laboratory and laboratory facilities, inadequate staff motivation, inadequate instructional materials and so on. Against this backdrop, this study is out to investigate the effect of metacognitive reading strategies on students' learning of Physics in Secondary in Ikere Local Government Area, Ekiti State of Nigeria. 'Reading' is a complex cognitive process of decoding symbols for the intention of deriving meaning (reading comprehension) and/or constructing meaning. It is the mastery of basic cognitive processes to the point where they are automatic so that attention is freed for the analysis of meaning [30]. According to O'Reilly and McNamara as quoted by [13] that nowadays researchers and science teachers agree that effective science reading is an essential prerequisite for better learning in this field, reading comprehension being a significant predictor of science performance. Moreover, access to and availability of textbooks is a significant predictor of academic achievement (Oakes and Saunders, 2004) as quoted by [13]. [7] stretched that "reading science text and textbooks requires the same critical thinking, analysis, and active engagement as performing hands-on science activities". Reading proficiency in science is essential for better comprehension. Physics teaching - learning from textbooks have a number of advantages according to [9] which includes among others: the students will have an unambiguous set of notes for the course (before attending any lectures), the lecturer is freed to (although not required to (spend more time on other activities such as problem solving, or on discussing the key issues, students can be encouraged to read materials in advance of lectures and it will aid the tutorials/workshops/example classes as other staff can also easily see what the students should and shouldn't know. Textbook is a book that treats a subject comprehensively and is used by students as a basis for study. [13] affirmed that textbooks represent an important resource for instruction and often teachers have the freedom to decide which textbook is more appropriate for teaching the topic presented in the national curricula. [13] further stretched that textbook authors also have freedom to develop their own approach to the delivery of national curricula and thus textbooks represent a considerable diversity. Resultantly, the teachers have the freedom to choose the textbook they consider to be appropriate for students in their class. Apart from having access to good science textbooks, students must have effective reading strategies for better learning in the field. Students need to have efficient reading strategies to learn successfully (Yore et al 1998 quoted in [13]. Metacognition is "thinking about thinking" [27]; [26]; and [12]. [8] also affirmed that metacognition literally means "big thinking". You are thinking about thinking. Students learn only through metacognitive activities by involving in thinking about thinking. This method enables them to have deeper understanding of the text theme or topic. [8] cited Fogarty that metacognition is a three-part process that to be a

successful thinkers, students must : (i) develop a plan better reading (i.e. good readers plan before reading); (ii) monitor their understanding of text, use "fix-up" and (iii) evaluate their thinking after reading. Cognitive strategies are used to help an individual achieve a particular goal (e.g., understanding a text) while metacognitive strategies are used to ensure that the goal has been reached (e.g., quizzing oneself to evaluate one's understanding of that text). Metacognitive experiences usually precede or follow a cognitive activity. They often occur when cognitions fail, such as the recognition that one did not understand what one just read. Such an impasse is believed to activate metacognitive processes as the learner attempts to rectify the situation [24].

2. Research Questions

1. Does the metacognitive strategies applied before reading any Physics Textbooks by Physics students in Secondary schools?
2. Does the metacognitive strategies applied during reading any Physics Textbooks by Physics students in Secondary schools?
3. Does the metacognitive strategies applied after reading any Physics Textbooks by the Physics students in Secondary schools?

3. Methodology

The design was a descriptive survey. The target population for this study comprised of all senior secondary class II (SS 2) Physics students in all the public secondary schools in Ikere Local Government Area of Ekiti State. Stratified random sampling technique was used to select twenty (20) students each from each of the five (5) selected secondary schools from Ikere Local Government Area of Ekiti State. A total of one hundred (100) students were used as samples for the study, these comprise of sixty eight (68) male and thirty two (32) female. The instrument used for this study was questionnaire. The questionnaire is designed to elicit information in the three major areas of metacognitive strategies of reading and learning from Physics textbooks by the Physics students namely: (i) The Strategies before reading; (ii) The Strategies during reading; and (iii) The Strategies after reading. Preliminary contacts were made with the selected schools, and heads of schools for easy schedule of itinerary for administration of instrument. With the permission of the authorities of the schools used for the study, the questionnaires were administered on the affected Senior Secondary class 2 Physics students. The questionnaire copies were then collected back and each of them was scored accordingly and the data collected were later subjected to Chi-square(X^2) statistical analysis.

4. Result and Discussion

4.1 Research Question 1

Does the metacognitive strategies involved before reading Physics Textbooks by the Physics students in Secondary schools?

Table 1: Chi- Square Analysis of Data on the metacognitive strategies applied before reading Physics Textbooks by the Physics students in Secondary schools

S/N	ITEMS	SA	A	D	SD	X ² -cal	x ² -tab	df	Rmk
1	I know what teacher expects from me to learn from the Physics textbook	18	36	24	22	7.20	7.82	3	**S
2	Before I start learning a new lesson, I ask questions regarding the material I have to learn	20	22	37	21	7.76	7.82	3	**S
3	I think of what I have to study before I open any Physics textbook.	20	35	25	20	6.00	7.82	3	**S
4	I think of what I stand to gain after reading any Physic textbook before picking it for reading	16	28	24	32	5.60	7.82	3	**S
5	I know the area of any Physic textbook I want before reading	18	24	36	22	7.22	7.82	3	**S

(p >0.05, **S = Not Significant)

A look at Table 1(for items No 1,2,3,4 & 5 in the questionnaire) reveals that x²-cal = 7.20,7.76,6.00,5.60 and 7.22 respectively and while x²-tab = 7.82 in each case , showing that x²-calculated is less than x²-table value in each case at p >0.05 and df=3 (i.e. x²-cal < x²-tab). Therefore, the result is not significant (i.e. the result shows negative affirmation), showing that most Physics students do not know what teacher expects from them to learn from the textbook before taking for reading, most Physics students do not ask questions from themselves before regarding the materials to learn, most Physics students do not think of what they have to study before they open any Physics textbook for reading, most Physics students do not think of what they stand to gain after reading any Physics textbook before picking it for reading and most of them do not know the area of any Physics textbook they want before reading.

4.2 Research Question 2

Does the metacognitive strategies applied during reading any Physics Textbooks by the Physics students in Secondary schools?

Table 2: Chi- Square Analysis of Data on the metacognitive strategies applied during reading Physics Textbooks by the Physics students in Secondary schools

S/N	ITEMS	SA	A	D	SD	X ² -cal	x ² -tab	df	Rmk
1	I can identify the relevant information when reading from the Physics textbook	21	28	23	28	1.52	7.82	3	**S
2	I slow down learning when I encounter important information.	15	31	34	22	9.72	7.82	3	*S
3	I consciously focus my attention on relevant information.	20	23	33	24	4.92	7.82	3	**S
4	When I do not understand a particular concept, I stop and I read the paragraph again.	25	17	33	25	5.12	7.82	3	**S
5	I use my own examples in order to better understand the information I read.	19	36	25	20	7.28	7.82	3	**S

(p<0.05, *S = Significant), (p >0.05, **S = Not Significant)

The result in Table 2 (for item No 2 in the questionnaire)reveals that x²-cal = 9.72 while x²-tab = 7.82 showing that x²-calculated is slightly greater than x²-table

value at p<0.05 and df=3 (i.e. x²-cal > x²-tab). Therefore, the result is significant, showing that most Physics students involved in the study slow down learning when encounter important information for better understanding. But for items No 1,3,4 & 5 in the questionnaire, x²-cal = 1.52,4.92,5.12 and 7.28 respectively and while x²-tab = 7.82 in each case , showing that x²-calculated is less than x²-table value at p >0.05 and df=3 (i.e. x²-cal < x²-tab). Therefore, the result is not significant (i.e. negative affirmation), showing that most Physics students cannot identify the relevant information when reading most Physics textbooks, most of them were not consciously focus attention on relevant information, most of them do not stop and read the paragraph again when they seem not understand a particular concept and most Physics students do not use their own examples in order to better the information they read.

4.3 Research Question3:

Does the metacognitive strategies applied after reading any Physics Textbooks by the Physics students in Secondary schools?

Table 3: Chi- Square Analysis of Data on the metacognitive strategies applied after reading Physics Textbooks by the Physics students in Secondary schools

S/N	ITEMS	SA	A	D	SD	X ² -cal	x ² -tab	df	Rmk
1	I assess to what extent what I already know and connects to the new information.	25	30	24	21	1.68	7.82	3	**S
2	I evaluate if I understood the information.	30	25	29	16	4.40	7.82	3	**S
3	I regularly revise the text in order to better understand the relevant information.	20	32	29	19	5.04	7.82	3	**S
4	After I finished reading a topic, I summarize what I read.	35	23	17	25	6.72	7.82	3	**S
5	Most of the mathematical concepts/ calculation there in Physics textbooks are difficult for me to remember	18	41	20	21	21.31	7.82	3	*S

P < 0.05, *S = Significant

Also, a cursory look at Table 3(for items No 1,2,3, & 4 in the questionnaire) reveals that x²-cal = 1.68,4.40,5.04 and 6.72 respectively and while x²-tab = 7.82 in each case , showing that x²-calculated is slightly less than x²-table value in each case at p >0.05 and df=3 (i.e. x²-cal < x²-tab). Therefore, the result is not significant (i.e. the results show negative affirmation), showing that most science students do not make use of metacognitive strategies after reading most science textbooks. But, the analysis of the item No 5 in the questionnaire revealed that x²-cal = 21.31 while x²-tab = 7.82 showing that x²-calculated is highly greater than x²-table value at p<0.05 and df=3 (i.e. x²-cal > x²-tab). Therefore, the result is highly significant, showing that most students find mathematical concepts/ calculation there in the textbook difficult to comprehend.

5. Discussion

The results of the study were discussed based on the three general questions. Table 1(for items No 1,2,3,4 & 5 in the questionnaire) reveals that x²-cal = 7.20,7.76,6.00,5.60 and 7.22 respectively and while x²-tab = 7.82 in each case , showing that x²-calculated is less than x²-table value in each case at p >0.05 and df=3 (i.e. x²-cal < x²-tab). Therefore, the

result is not significant (i.e. the result shows negative affirmation), showing that most Physics students do not know what teacher expects from them to learn from the textbook before taking for reading, most Physics students do not ask questions from themselves before regarding the materials to learn, most Physics students do not think of what they have to study before they open any Physics textbook for reading, most Physics students do not think of what they stand to gain after reading any Physics textbook before picking it for reading and most of them do not know the area of any Physics textbook they want before reading. The result negate the submission of [13] that the use of metacognitive strategies are essential before reading since the use of these types of strategies help the students to focus their attention on what they have to learn, and on exploring what they already know about the subject they will read about. The result in Table 2 (for item No 2 in the questionnaire) reveals that $\chi^2\text{-cal} = 9.72$ while $\chi^2\text{-tab} = 7.82$ showing that $\chi^2\text{-calculated}$ is slightly greater than $\chi^2\text{-table}$ value at $p < 0.05$ and $df=3$ (i.e. $\chi^2\text{-cal} > \chi^2\text{-tab}$). Therefore, the result is significant, showing that most Physics students involved in the study slow down learning when encounter important information for better understanding. But for items No 1,3,4 & 5 in the questionnaire, $\chi^2\text{-cal} = 1.52, 4.92, 5.12$ and 7.28 respectively and while $\chi^2\text{-tab} = 7.82$ in each case, showing that $\chi^2\text{-calculated}$ is less than $\chi^2\text{-table}$ value at $p > 0.05$ and $df=3$ (i.e. $\chi^2\text{-cal} < \chi^2\text{-tab}$). Therefore, the result is not significant (i.e. negative affirmation), showing that most Physics students cannot identify the relevant information when reading most Physics textbooks, most of them were not consciously focus attention on relevant information, most of them do not stop and read the paragraph again when they seem not understand a particular concept and most Physics students do not use their own examples in order to better the information they read. Metacognitive strategies used during reading a text increase the active cognitive processing of that text and, as a consequence, the reading comprehension and science achievement (Herman et al, 2008 cited in [13]. Table 3 (for items No 1,2,3, & 4 in the questionnaire) reveals that $\chi^2\text{-cal} = 1.68, 4.40, 5.04$ and 6.72 respectively and while $\chi^2\text{-tab} = 7.82$ in each case, showing that $\chi^2\text{-calculated}$ is slightly less than $\chi^2\text{-table}$ value in each case at $p > 0.05$ and $df=3$ (i.e. $\chi^2\text{-cal} < \chi^2\text{-tab}$). Therefore, the result is not significant (i.e. the results show negative affirmation), showing that most science students do not make use of metacognitive strategies after reading most science textbooks. But, the analysis of the item No 5 in the questionnaire revealed that $\chi^2\text{-cal} = 21.31$ while $\chi^2\text{-tab} = 7.82$ showing that $\chi^2\text{-calculated}$ is highly greater than $\chi^2\text{-table}$ value at $p < 0.05$ and $df=3$ (i.e. $\chi^2\text{-cal} > \chi^2\text{-tab}$). Therefore, the result is highly significant, showing that most students find mathematical concepts/ calculation there in the textbook difficult to comprehend. This result supported the claim of [13] that even if students use moderately metacognitive strategies when reading science textbooks, they encounter some difficulties, which make studying science quite difficult, difficulties such as too many formulas, difficult concepts and too much theory. Finally, The use of metacognitive strategies helps students to "think about their thinking" before, during, and after they read [23].

6. Conclusion

As a result of findings of this study, it is concluded that "application of Metacognitive strategies" has significant impact on the reading and learning of Physics students and their academic performance in Physics in secondary schools in Ikere Local Government Area of Ekiti State, Nigeria. As a result of not applying the metaconitive strategies of reading and learning (i.e thinking of what to read before taking the textbook, thinking of what you are reading during reading and thinking on what you have gained after reading), the students may not have better performance in any given examination .

7. Recommendations

Based on the findings of this study however, it is strongly recommended that secondary school Physics textbook authors should make their text/write-up to be readable by ensuring legibility of the print and mathematical aspect should be well simplified, sentence structure should not be difficult to aid their learning through reading and enhance their better academic achievement in internal and public Physics examinations. It is also recommended that Physics textbook authors should try as much as possible to use familiar (local) analogy while explaining some Physics concepts in their text to reduce the perceived abstract nature of the subject to a vivid reality. Furthermore, it is also recommended that Physics educators should create enabling environment to foster students' interest and motivation in the textbook reading. The teachers should evaluate the reading level of students and readability of the Physics textbooks in order to choose the appropriate textbooks for a given class level of students. Moreover, it is also recommended that instructions to examination questions should be legible and the sentence structure be less ambiguous for candidates' better interpretation. Finally, it is recommended that the Physics textbook writers should be conversant with various "text readability" formulas to analyse the reading ease of their texts, determining unusual words and the ambiguity of sentence(s) in their text for a particular age bracket of students for their better academic performance in schools.

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