TEXTUAL MATERIAL VARIABLES AS CORRELATE OF STUDENTS' ACHIEVEMENT IN MATHEMATICS

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Abstract:
Textbook is the learning aid closest to the students and the closest teaching aid to the teachers. It is one of the factors responsible for low or dwindling achievement of students in mathematics. With its paramount position in the classroom teaching-learning process, the few researchers on textbooks globally reported that textbook has been understudied. This is one of the few studies along the line of content analysis of mathematics textbooks. This study is a descriptive survey which considered the correlation of the textual material variables and its predictive capability on students' achievement in mathematics. The study was carried out in the 6 states of south-west zone of Nigeria. Senior school students (n = 2,490) were selected on stratified random sampling technique along the senatorial districts of each state. Mathematics teachers (n = 117) were purposively selected in the same schools as respondents. Two instruments Recommended Mathematics Textbook Rating Scale (r = 0.79) and Mathematics Achievement Test (r = 0.71) were used to collect data from teachers and students respectively. Multiple regression was used for data analysis. The result reveals that the four independent variables (availability, relevance, suitability and adequacy of textbook features) had positive multiple correlation (R = 0.342) with students' achievement in mathematics. The independent variables made significant contribution ($F_{4, 116} = 3.704$; $p<0.05$) to the tune of 8.5% of total variance on students' achievement in mathematics. None of the variables could predict students' achievement in mathematics because none of the variables independently made significant contribution to students' achievement in mathematics. This indicates the mutual importance of these four variables and should be taken together to enhance mathematics achievement. Mathematics textbooks should cover the scope documented in the curriculum with relevant contents and standard of activities and tasks which caters for learners of various intellectual capabilities.

Key Words: Variables, Achievement, Textbook Analysis, Mathematics Textbook, Correlate

Introduction

Textbook is imperative to schooling and school programme. To the teachers, it is a major source of lesson preparation, to check up for theorems, proofs, formulae, take up assignments, tests and examinations (Kajander and Lovric, 2009). It is a primary source of document (Kajander, 2007). It also serves major source of learning tools for the students, for their studies, home works and questions (Kajander and Lovric, 2009).

Efforts have been put into research on mathematics teaching methods by many researchers such as Douville and Pugalee (2003), on learning difficulties by Sharma (2001), we rarely think about studying the textbooks themselves (Kajander and Lovric, 2009). Hence, few researchers on mathematics textbooks exist (Johansson, 2003; Afolabi, 2010; Pugalee, 2001; Morgan, 1998).

One of the principal directions in which research on mathematics textbooks have existed is that on content analysis. Afolabi (2010) has identified four types of mathematics textbook content analysis. Pepin and Haggerty (2001), Valverde (2002), TIMSS(1994/95) studied content analysis by distinguishing textbooks according to countries, Harries and Sutherland(1999), Li (2000), project 2061 of AAAS (2000) studied content analysis using bench-mark approach (i.e. restriction to some selected mathematics concept). Content analysis has also taken the form of comparing how adherence the textbooks are towards the official goals and objectives of mathematics education as could be found in the works of Chandler and Brosnan (1995), Afolabi (2010). Lastly, the research of Johnsson

(2003) on content analysis of mathematics textbook which deals with content analysis of a series of mathematics textbooks over a trend of time in which many editions have existed. In such case the contents in various editions were compared.

The mathematics content to be learnt is the heart of the matter; thus, it dictates what other parameters will serve as enabling factors that have to come around it in learning through textbook. The parameters considered in this study include the 'objective'. The topical, sub-topical objectives accessibility to students, fulfilment of the intention of senior secondary school (SSS) mathematics curriculum.

The content- if there are prerequisite knowledge or not, organization and sequential hierarchy of concepts, worked examples, content of teachers' guide, students' workbook, are they available? Are they relevant, suitable or adequate when compared with the expectations and the intentions of SSS mathematics curriculum?

Learners' Activities: asked if learning activities are created or suggested. Are they practical oriented, learners centred?

Evaluation: Are there accurate answers to exercises, relevance of tasks to worked examples, are they structurally progressive, hierarchical? Provision for individual differences-weak and brilliant students, volume and standard of tasks, order of tasks in terms of depth of knowledge and coverage of the curriculum.

Presentation format: deals with Psychological dimensions which can appeal to learners interest. These are: colour, photographs, pictures, illustrations, font type, font size, gender illustrations, accessibility unhindered by cost or quantity.

Language of presentation: Assessment of the language of instruction, language of the subject matter, how short and simplified, correctness of spellings, communicative ability of the language of instruction and the language of the subject matter.

Other parameters examined include hierarchy of tasks, worked examples, solutions/keys to exercises teachers' guide, and students' workbook.

These parameters were measured in comparison with the goals and objectives or intentions of SSS mathematics curriculum. These were measured under four (4) principal variables- 1) the availability of the above parameters in the textbooks. 2) Their relevance to the set curriculum. 3) Their suitability for the curriculum. 4) The adequacy of measures. Considering the needed high level of in-depth acquaintance with the textbook, to be able to give valid responses, the mathematics teachers who *have used* the textbooks for some years (at least three years) were considered eligible to respond to the items, unlike Project 2061 (2000) that made use of expert mathematics researchers, mathematics teachers and mathematics educators who were not necessarily users of the textbooks.

This study is also similar to that of project 2061 (AAAS 2001) in that some of these textbook features were also used as their parameter for mathematics textbook analysis. This study is also in line with Chandler and Brosnan (1995) in that it investigated the adherence of the textbooks towards official goals and objectives (requirements) of senior school mathematics curriculum).

All the parameters were measured under the 4 variables in terms of their availability relevance, suitability and adequacy. Availability of these parameters was measured as present or absent. Relevance has to do with whether these features are relevant to the demand of the curriculum and the extent of their relevance. Suitability measures the standard of the content as not below or above it. It is a measure of appropriateness with the target audience. Adequacy of features measures scope of coverage, either sufficiently enough or not as demanded by the mathematics curriculum. Johansson (2003) summarily concluded that the approach of textbook analysis is a function of questions to be answered.

It is not only instructional strategies (Ogunbiyi, 2004; Afolabi, 2001) or teachers' characteristics (Yara, 2008) that can affect mathematics achievement, researchers such as Douville and Pugalee (2003,) Ilori (2003), Okwilagwe (2001), Afolabi (2010) have also identified textbook as one of the factors for students' decline or poor achievement in mathematics. Textbook presentation in relation to gender affects achievement (Chibuogwu, 2006; Owolabi and Onafowokan, 2001) in mathematics. Halai (2010) opined that curriculum content especially textbook does also reinforce gender stereotypes in mathematics. He also reported Shah and Ashraf (2006), Halai (2006) that deep-rooted cultural and social biases about gender roles and expectations permeate textbook and teachers'

thinking in Pakistan. These do indicate that the effect of textbook on mathematics achievement is a worldwide phenomenon. Pugalee (1997), Kenyon (1989), Tobias (1989) reported that writing has been found to be inherently related to the development of metacognitive behaviours.

This study considered how the textbook variables have affected mathematics achievement. The study considered the relationships that exist among the textbook variables. It also considered the joint effect of the variables on mathematics achievement and also how each of them could relate or predict mathematics achievement. In the study textual materials refers to the recommended and used mathematics textbook by the teachers and students.

Research Questions

The following research questions have been answered by the study.

1. What is the composite contribute of textual material variables (availability of textbook factors, relevance of textbook factors, suitability of textbook factors, adequacy of the factors) to students' achievement in mathematics?
2. What is the relative contribution of;
   (i) Availability of textbook factors
   (ii) Relevance of textbook factors
   (iii) Suitability of textbook factors
   (iv) Adequacy of the factors to students' achievement in mathematics?
3. Which of the textual material variables will predict students' achievement in mathematics?

Methodology and procedure

The study is a descriptive survey carried out in 6 states of south-west zone of Nigeria. A total of 2,490 senior school students were selected following a stratified order along the senatorial axis in each state. Two schools were randomly selected from each senatorial district. (There are 3 senatorial districts in each state). Teachers (n=117) were purposely selected with the following criteria: (1) they have taught the students with the textbook in the same school (2) they are teachers of senior school students (3) they are mathematics teachers (4) they have used all the series in the book.

The data were collected by the researcher and his assistants over a period of about twelve weeks.

Instrumentation

Two instruments were used for data collection after validation, trial tested and ascertaining the reliability of the instruments.

1. The Recommended Mathematics Textbook Rating Scale (REMTERS) was an instrument used for the teachers. They were to respond on the availability, relevance, suitability and adequacy of features of the textbooks presented. These features were summarised under 11 attributes which include: statement of objectives, content, learners' activities, evaluation, presentation format, language, hierarchy of tasks and that of examples, worked examples, solutions/keys to exercises, teachers' guide and students' workbook.

   Each variable had different response format. Availability of the features had 2 response formats (available, not available) while relevance, suitability and adequacy had 3 response formats. Availability was scored as '0' and '1' for not available and available respectively. While 3 other variables were scored as 0,1,2, based on the degree of presence of the attribute. The reliability coefficient of availability section was 0.79 while other sections had 0.76 with Cronbach Alpha.

2. Mathematics Achievement Test (MAT) was a carefully drawn instrument with 40 multiple choice questions (options A-E). Table of specification was used to select these items. Instrument was trial tested on students of this level but outside the used sample. The internal coefficient of consistency yielded 0.71 (KR-20). Only 25 relevant items remained for MAT.

Findings and discussions
Correlation of Variables

Table 1: Matrix of Correlation of Independent Variables on Dependent Variable

	Avail.	Relev.	Suitab.	Adeq.	Ach.
Avail.	1				
Relev.	.400**	1			
Suitab.	.070	.605**	1		
Adeq.	.212*	.580**	.699**	1	
Ach.	-.047	.261**	.230*	.272**	1

* Correlation is sig. at 0.05 level (2_tailed) ** Correlation is sig. at 0.01 level (2_tailed)

Table 1 shows the correlation matrix among the variables. The table revealed the correlation between each pair of variables. It also revealed the strength of correlation (correlation coefficient, r) between each pair. Those pairs of variables that are significant at 0.01 (2-tailed) are indicated (**) and those that are further significant at 0.05 (2-tailed) are indicated (*). As it is normative in behavioural science to use 0.05 level of significance, this has been chosen here for decision.

There is significant correlation between adequacy of textbook features and availability of textbook features, r = 0.212. There is significant correlation between suitability of textbook features and achievement, r =0.230. These are the only two pairs of variables that are significantly correlated.

Research Question One

What are the composite and relative contributes of textual material variables (availability of textbook factors, relevance of textbook factors, suitability of textbook factors, adequacy of the factors) to students' achievement in mathematics?

Table 2: Regression Analysis of Variance of Textual Material Variables on Students Achievement in Mathematics

R = .342 **R^2= .117** **Adjusted R^2 =.085** **S.E =3.0272**					
Source of variation	**Sum of square**	**Df**	**Mean**	**F**	**Sig. F**
Regression	**135.766**	**4**	**33.941**	**3.704**	**.007***
Residual	**1026.342**	**112**	**9.164**		
Total	**1162.108**	**116**			

*** Sig. at p<0.05**

Table 2 shows that the multiple regression correlation coefficient (R) which indicates the relationship among textual material variables (availability, relevance, suitability and adequacy of textbook features) and students' achievement in Mathematics is 0.342. This implies that there is positive relationship among the textual material variables and students' achievement in Mathematics. R^2 = 0.117 and adjusted R^2 is 0.085. This indicates that the four textual material variables have jointly contributed 8.5% to total variance of students' achievement in Mathematics.

The table also reveals the linear relationship among textual material variables and students' achievement in Mathematics. The regression ANOVA F(4,116) =3.704; p<0.05. It means that there is significant composite contribution of these four textual material variables on Mathematics achievement when taken together. It implies that a combination of textual material factors is significantly related to student achievement in mathematics.

Research Question Two:

What is the relative contribution of;
(i) Availability of textbook factors
(ii) Relevance of textbook factors

(iii) Suitability of textbook factors

(iv) Adequacy of the factors to students' achievement in mathematics?

Table 3: Relative Contributions of each of the Textual Material Variables on Students' Achievement in Mathematics.

Independent variables (Predictors)	Unstandardized coefficients		Standardized coefficients	Rank	T	Sig. t
	B	Std Error	Beta			
(Constant)	-6.242	1.580			3.952	.000
Availability of textbook features	-.153	.083	-.185	3rd	-1.839	.068
Relevance of textbook features	.099	.051	.247	1st	1.936	.055
Suitability of textbook features	-.018	.053	-.046	4th	-.339	.735
Adequacy of textbook features	.053	.034	.200	2nd	1.540	.126

Beta weights which indicate the relative contributions of textual material variables on students' achievement in Mathematics are shown in table 3. The contribution of each of the predictor to criteria variable (Mathematics achievement) are: availability of textbook features: β= -.185, ($p>0.05$); relevance of textbook features: β= .247, ($p.>0.05$); suitability of textbook features: β = -.046 ($p>0.05$); adequacy of textbook features: β=.200, ($p>0.05$). Relevance of textbook features is having the highest contribution to students' achievement in Mathematics, suitability being the least contributor. However, none of the four variables have significant relative contribution to students' achievement in Mathematics.

Research Question Three

Which of the textual material variables will predict students' achievement in mathematics?

From table 3, none of the textual material variable has impacted enough as to predict students' achievement in mathematics, since none of them could make a significant relative contribution. It therefore implies that the four variables must be taken together.

Discussion

The four textual material variables investigated are availability, relevance, suitability and adequacy of textbook features in consonance with SSS Mathematics curriculum and for desirable learning achievements. The textbook features examined under these four variables are eleven. These are (1) *objectives* –learners' access to topical objectives, sub topical objectives, fulfilment of the objectives of SSS Mathematics curriculum (2) *content* – necessary prerequisite idea or skill, sequential order of contents, answers to exercises, worked examples and exercises in relation to SSS Mathematics curriculum, hierarchy of examples, arrangement of topics and sub-topic in appropriate hierarchy of knowledge, worked examples in relation to exercises, content coverage: of final examination syllabus, of SSS Mathematics curriculum (3) *Learners' activities*- avenue created for students learning activities in the course of the lesson, suggested learners' activities, practical oriented activities, learner-centred activities, (4) *lesson evaluation* – remediation and accurate answers to exercises, exercises in relation to worked examples, progressive hierarchy of exercises, exercises for weak students, exercises for brilliant students, number and variety of exercises, standard of exercise, exercises' coverage of SSCE, systematic arrangement of exercises in order of in-depth of knowledge. (5) *Presentation format* – attractive pattern of layout, motivating presentation /outlook, photographs, pictures and diagrams, multiple colours, attractiveness, gender illustration/representation, students' accessibility unhindered by cost and quantity. (6) *Language* –familiarity, simplicity, communication ability of language of instruction and of the subject matter. (7) *Progressive hierarchy of tasks* – examples and exercises (8) *Worked examples* (9) *Solutions/keys to exercises* (10) *Teachers' guide/manual* (11) *Students' workbook.*

The four variables taken together had a positive correlation with students' achievement in Mathematics. They jointly made significant contribution to students' achievement in Mathematics. The result obviously appeals to logical reasoning. In that if the textbooks have the necessary features described above, their relevance, suitability and adequacy can be measured. This finding indicates that the relevance of the textbook features are as important as the appropriateness of the standard (suitability) for the users to whom it is recommended. No matter the relevance of a textbook in terms of addressing the requirement of the curriculum content, the issue of meeting the need and standard of the target audience is very paramount. The relevance of the textbook may be baseless if the standard of the material is too low or too high. Low standard can cause boredom while that which is too high above the ability of the students can put off the learner. An appropriate textbook should possess well graded activities and tasks of various standard for all levels of achievers, be it low, medium or high achievers. The importance of adequacy of the textbook features which defines the coverage of the stipulated concepts in content and in context (enabling psychological factors such as features on presentation format, language etc) is also revealed like any other variables. Without adequate coverage of the content of the curriculum using such textbook will make both the students and teachers to leave many stones unturned. It is clear that the examining bodies will consider the contents expected to be learnt through the objectives set in the curriculum and not the textbook. It is a recommended textbook (in school use) with full and complete coverage of these features that can enhance high achievement.

In this study, none of the variables on its own made significant relative contribution to achievement even though the relevance of textbook features did greatly impact much contribution which is not statistically significant. The implication of this to Mathematics achievement is that all these four factors are to be essentially considered to ensure high achievement. All the four are to be taken together to enhance achievement because they are equally important. This explains why all the four variables made significant composite contribution to mathematics achievement and none of them made relative significant contribution to student achievement.

These findings are in line with the recommendations of Kochhar (1985) and the findings of Sousa (2001), Douville and Pugalee (2003) who said simple and clear language, pictures and diagrams should be used in illustration of ideas in textbooks. Books that are made available in enough quantity with low cost will afford accessibility. The findings also imply that textbooks with very relevant and very adequate content coverage, meaningful learners' activities, and well graded evaluation exercises with good presentation format will increase achievement.

Conclusion and recommendations

There is positive linear relationship between the textual material variables and student achievement in mathematics. The four variables jointly contributed 8.5% to students' achievement in mathematics. The joint contribution of the four variables is significant at 0.05 level. None of the textual material variables could contribute at 0.05 level of significance as to predict students' achievement in mathematics. The four variables must be taken together in subsequent studies. Mathematics textbooks should cover the documented scope required by the curriculum, providing appropriate tasks for all categories of students.

Limitation and Further Studies:

Teachers are the assessors or evaluations of the textbooks, this is credible but the students might have access to some textbooks or teaching materials that are not recommended or used by the school. Thus the types of books and materials culminate and had in one way or the other enhanced students' achievement. For further one may make the students to analyse the textbooks as well and then correlate this with their achievement. This is recommended as area for further studies.

References:

Afolabi, S. S. 2010. Teaching Method And Textual Material Variables As Correlate Of Students' Learning Outcomes In Senior Secondary School Mathematics. Ph.D Thesis. Department Of Teacher Education. University Of Ibadan. Ibadan. Xvi +152.

Afolabi, S.S. 2001. A Comparative Effectiveness Of The Problem Solving Strategy And Advanced Organizer Strategy In Teaching Mathematics Word Problems At The Senior Secondary School. M.Ed Dissertation. Dept. Of Teacher Education. University Of Ibadan. Xii + 63pp.

American Association For The Advancement Of Science. (Aaas). 2000. The Nature Of Mathematics. *Science For All American Online*. (Prag2) Retrieved Feb. 16, 2007 From. Http://Www.Project2061. Or/Publications/Sfaa/Online/Chap2.Htm

Chandler. D. G. And Brosnan, P. A. 1995. A Comparison Between Mathematics Textbook Content And A Statewide Mathematics Proficiency Test. *School Science And Mathematics.* 95.3:118-123.

Chibuogwu, V. N 2006. Enhancing Female Students' Participation In Science, Technology And Mathematics Education (Stme) Through Gender-Fair Instructional Behaviour. In E. Okeke; M Opara *Stan: Gender And Stm Education Series*.1

Douville, P. And Pugalee, D.K. 2003. Investigating The Relationship Between Mental Imaging and Mathematical Problem Solving. *Proceedings Of The International Conference Of Mathematics Education Into The 21st Century Project September 2003.* Ed. Brno.Czech Republic:62-67.

Halai, A. 2006. Boys Are Better Mathematicians: Gender Issues From Mathematics Classrooms In Pakistan. In J. Rarieya And R. Qureshi (Eds). *Gender And Education In Pakistan. Karachi.* Oxford University Press.

Halai, A. 2010. Gender And Mathematics Education In Pakistan: A Situation Analysis. *The Montana Mathematics Enthusiasts.* Vol. 7 No. 1. Pp 47-62. (Downloaded 14/10/2010.

Harries, T. And Sutherland, R. 1999. Primary School Mathematics Textbooks: An International Comparison. In I.Tompson. Ed., *Issues In Teaching Numeracy In Primary Schools. Buckingham*: Open University Press.

Ilori, S.A. 2003. Effective Teaching And Learning Of Mathematics In The Free Education Programme- Implications For Students, Parents And Society *Oyo State Journal Of Mathematical Association Of Nigeria* 2.1:17-21.

Johansson, M. 2003. Textbooks In Mathematics Education: A Study Of Textbooks As The Potentially Implemented Curriculum. Licentiate Thesis. Department Of Mathematics. Lulea University Of Technology. Xi + 88pp. Retrieved March, 7 2008 From Http://Www.Sciencedirect.Com /Science/Journal/0191491x

Kajander, A. 2007. Describing Mathematics Teachers' Growth. Presentation To The Education Forum Of The Fields Institute For Mathematical Sciences, University Of Toronto, Toronto.

Kajander, A. And Lovric, M. 2009. Mathematics Textbooks And Their Potential Role In Supporting Misconceptions. International Journal Of Mathematical Education In Science And Technology. 40.2; 173-181. (Downloaded On 24 February, 2011 At Http://Www.Informaworld.Com/Smpp/Title-Content=T713736815).

Kenyon, R. 1989. Writing In Problem Solving. In P. Connolloy & T. Vilardi. Eds. *Writing To Learn Mathematics And Science*. N.York. Teachers College Press. 73-87.

Kochhar, S.K. 1985. *Methods And Techniques Of Teaching* New Delhi. Sterling Publishers Private Limited

Li, Y. 2000. A Comparison Of Problems That Follow Selected Content Presentations In American and Chinese Mathematics Textbooks. *Journal For Research In Mathematics Education*. 31.2:234-241.

Li, Y. 2000. A Comparison Of Problems That Follow Selected Content Presentations In American And Chinese Mathematics Textbooks. *Journal For Research In Mathematics Education*. 31.2:234-241.

Morgan, C. 1998. *Writing Mathematically: The Discourse Of Investigation.* London. Falmer Press. National Academy Press.

Ogunbiyi, O. 2004 New Challenges In The Methodologies Of Teaching: A Case For In- Service Programme For School Teachers. *Teachers' Mandate On Education and Social Development In Nigeria*. D.F. Elaturoti And A. Babarinde Eds. Nigeria Stirling- Horden Publishers. 152-157.

Okwilagwe, O.A. 2001. *Book Publishing In Nigeria*. Ibadan. Stirling- Horden Publishing.

Owolabi, T And Onafowokan, B.A. 2001. The Gender Balance Of Science Textbooks: Implications To Learning. In O.O Busari (Ed) Women In Science Technology And Mathematics Education in Nigerian 373-375.

Pepin, B. And Haggarty, L. 2001. Mathematics Textbooks And Their Use In English, French and German Classrooms: A Way To Understand Teaching And Learning Cultures. *Zentralblatt Fuer Didaktik De Mathematik*, 33.5:158-175

Project 2061. 2000. Importance Of Mathematics For A Future Career. University Of North British Colombia. Retrieved Feb. 16, 2007 From Htt://Www.Unbc.Calmath/Mathlmportance.Htm.

Pugalee, D.K. 2001. Writing, Mathematics And Metacognition: Looking For Connections Through Students' Work In Mathematical Problem Solving. *School Science And Mathematics*.101.5:5236-245.

Pugalee, D.K. 1997. Connecting Writing To The Mathematics Curriculum. *Mathematics Teacher* 90:308-310.

Shah, A And Ashraf, D. 2006. Gender Analysis Of Textbooks: A Research Report. Aga Khan University Institute For Educational Development, Karachi.

Sharma, M.C. 2001. *Improving Mathematics Instruction For All*. Framingham. Center For Teaching/Learning Of Mathematics.

Sousa, D.A. 2001. *How The Special Needs Brain Learns Thousand Oak.* Ca: Corwin Press Inc, Sage.

Tobias, S. 1989. Writing To Learn Science And Mathematics. In D. Pugalee 2001. Writing, Mathematics, And Metacognition: Looking For Connections Through Students' Work in Mathematical Problem Solving. *School Science And Mathematics*. 101.5.

Valverde, G. A; Bianchi, L. J; Wolfe, R. G; Schmidt, W. H And Houang, R.T. 2002. According To The Book. Using Timss To Investigate The Translation Of Policy Into Practice Through The World Of Textbooks. Dordrecht: Kluwer Academics Publishers.

Yara, P. O. 2008. School Environment And Student Factors As Correlates Of Achievement In Secondary School Mathematics. Seminar Paper. Dept. Of Teacher Education. University Of Ibadan. Ibadan.