Lexical Ambiguity in Algebra, Method of Instruction as Determinant of Grade 9 Students' Academic Performance in East London District

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Abstract

In the domain of mathematics education there have been series of debates on lexical ambiguity in algebra especially with the resurgence of mathematics educators' awareness of the relevance of language in mathematics education. Therefore, this study investigated lexical ambiguity in algebra, method of teaching as determinant of grade 9 students' academic performance in East London. A pre-test-post-test- quasi-experimental group design was adopted in the study. A sample of 109 students was involved in the study. The instruments adopted and structured for the study were lexical ambiguity questionnaire (LAAQ). Method of Instruction Questionnaire (MIQ) Problem Based Learning Strategies in two parts (PBLSa) and (PBLSb), Conventional Teaching Guide (C.T.G). They were tested at .05 level of significance using a two-way (2 x 2) Analysis of Covariance (ANCOVA). The findings showed that students exposed to the PBLS achieved higher than their counterparts that were exposed to the Conventional method. Multiple Comparison Analysis and Tukey post-hoc were employed to detect the source of variation and the direction of significance. The findings also revealed that lexical ambiguity determines students' academic performance ($r=0.422$; $P<0.05$); effect of the experiment on students post-test performance scores in lexical ambiguity ($F(2,109)=.926$; $P<0.05$). Method of teaching is also said to be the determinant of students' performance ($r=0.764$, $P<0.05$). Hence, there is need for teachers to update their knowledge about the problem solving skills that can be used as a remedy to mathematics phobia and ambiguities in algebra word problem; it should also be enshrined into the school curriculum.

Keywords: *lexical ambiguity, linguistic proficiency, teaching method, algebra, mathematics, language*

1. Introduction

In education as a discipline, quality is connected with high students' academic performance or attainment which can improve the quality of human resources, and is directly related to increased individual earnings and productivity, economic growth and governments' ability to alleviate poverty in all ramifications. Though educators and researchers are yet to reach a consensus on the nature of educational quality and its determinants, it is typically measured by higher performance in examinations. In the recent times, studies have shown that the menace of poor performance in mathematics has become a global issue of concern.

The main objective of this study was (1) to explore lexical ambiguity as an aspect of linguistic complexity in relation to algebra learning and performance; (2) to ascertain the effect of the teaching methodology on students' performance. There has been a great deal of work directed at understanding students' difficulties in algebra teaching and learning, but there is no clear evidence that the studies have made a significant impact in terms of improving attainment. Indeed, the teaching and learning of algebra continues to be a major policy concern around the world (e.g. National Mathematics Advisory Panel, 2008).

In South African schools the teaching of algebra focuses on manipulative skills of simplifying, factorising, solving equation, functions and graph, variables, word problems and patterns. It is introduced to pupils around the ages of 13 and

14years.

Debates on the place of algebra in mathematics curriculum have been on-going, especially in a linguistically and ethnically diverse classroom like South Africa. A multitude of studies have acknowledged the effects of lexically ambiguous language on the construction and communication of accurate concepts Rutherford, 2000; Kaplan et al., 2009, 2010). Many anecdotal reports have revealed pupils' misinterpretation of algebraic expressions in an attempt to decode ambiguity in its everyday sense. Barwell, (2005) argued that lexical ambiguity does not always provide clarity learners need in order to make sense of algebra problem. Also, Schleppegrell, (2007) noted that ambiguity creates difficulty in mathematical communication. These are indications of the difficulties encountered in classroom teaching and learning and low achievement in mathematics among second language learners. However, the focus of this study is on the impact of lexical ambiguity in algebra and method of teaching on students' academic performance. .

Despite the importance of algebra in the classroom pedagogy there are many problems in the teaching and learning of the domain. Artigue & Assude (2000) suggested that many students see algebra as the area where mathematics abruptly becomes a non-understandable world. This has been the notion in 1982; the Cockcroft Report in the UK identified algebra as a source of substantial confusion and negative attitudes among students.

Linchevski (1994) argued that many students consider algebra as an unpleasant, alienating experience and find it difficult to understand. A related case of difficulty was discovered in Irish classrooms, where algebra was acknowledged as an area of difficulty for mathematics teachers in an Irish study carried out by McConway (2006). This is an indication that the pride of place algebra enjoyed in mathematics curriculum notwithstanding students still has challenges in comprehending and applying even its basic concepts.

1.1 Rationale for this study

There has been an abysmal performance of learner in algebra. It is therefore pertinent to gear research work in mathematics towards finding a solution to an aspect of mathematics. Hence, this study investigates the relationship between lexical ambiguity in algebra, method of teaching and students' academic performance. The study found out the variables that could predict students' academic performance in algebra. Several studies have explained the relationship between lexical ambiguity in algebra and students' academic performance.

However, no concrete effort has been geared towards the contribution of lexical ambiguity, method of teaching, and performance in order to capture the interplay of them within the domains of teaching and learning. This prompted the present researcher to embark on investigating the relationship among the stated variables and students' academic performance.

2. Literature Review

2.1 Linguistic complexity and Algebra Performance

Many studies have examined the effects of linguistic complexity of tests on Ell's performance (Abedi & Gandara, 2006; Herman & Dietel, 2010; Menken, 2010; Wolf, Herman, & Dietel, 2010; Young, 2009). The linguistic features of natural language that create comprehension difficulties for ELLs include vocabulary, lexical complexity/ambiguity. Again, language difficulty can be referred to as language complexity and in the context of this study it is equally referred to as lexical ambiguity. In the past few decades, empirical studies have shown the relationship between some linguistic features and the difficulty of algebraic word problem for ELLs and non-ELLs in elementary, middle and high school (Abedi et al., 2005; Shaftel, Belton-Kocher, Glasnapp, & Poggio, 2006). Even though, many of these studies predicted a relationship between linguistic complexity and ELLs performance in mathematics word problems, the effect of specific linguistic features varied from test to test and from one grade to another.

Many studies that have identified language as a source of differential performance between ELL and non-ELLs has attributed difficulty to students' understanding of the written text rather than their ability in mathematics, (Abedi & Gandara, 2006; Abedi & Plummer, 2006; Abedi et al., 2005; Martiniello, 2009; Wolf & Leon, 2009). The difficulty of language used in mathematics items is posited to have a disproportionate impact on ELL students due to their low language proficiency or general language skills (Abedi, 2004; Johnson & Monroe, 2004).

In South Africa, students' achievement in mathematics is affected by linguistic complexity because mathematics is taught and learned in a second language in schools both in the rural and urban centre (Fleisch, 2008; Taylor & Vinjevold, 1999). Some of the challenges students face is associated with the technical vocabulary of mathematics which includes the following:

1. The use of technical words or discrete set of mathematical terminology that are not usually used by students outside mathematics classroom.
2. There are many words that are used in everyday English, which have diverse or much more specific meanings in mathematics.
3. Words in mathematics are naturally used with specific meanings. But in ordinary everyday English, many mathematical words are misused or used with a degree of sloppiness, which can be a barrier to pupils' understanding of mathematical concepts.

2.2 Teaching Method and Students' Performance

The issue of teaching method in the classroom pedagogy is a global one ranging from which teaching methods are most effective, how to determine which knowledge to be taught, which knowledge is most relevant, and how well the learner will retain incoming knowledge. This has led to a change in the role of the teacher as a giver of information to the learners with the introduction of different concepts in the classroom instruction which include team teaching, individualized instruction, programmed learning, new buildings, television equipment, electronic learning laboratories, and computer assisted terminal learning, dial-access retrieval systems. These options have greatly increased a teacher's choice of ways to accomplish the specified learning outcomes.

Basically, teaching methods can be classified into two groups: the traditional and the modern or contemporary method. In traditional methods, teachers are saddled with too many responsibilities for teaching in the classroom to make sure everything they thought was understood by the student, the modern method, there consists of agreement between the teacher and student regarding on how each will contribute to and behave in the classroom to start building a student's expectation towards independence. Students even have a bonding relationship with their teacher to be their friend so that they can share their problems with the teacher without being afraid.

2.3 Problem Based Learning (PBL)

In at least the past half-century, there have been a lot of ongoing debates about the impact of instructional guidance during (Ausubel, 1964; Craig, 1956; Mayer, 2004; Shulman & Keisler, 1966). Some have argued that people learn best in an unguided or minimally guided environment, of which learners, rather than being presented with essential information, must discover or construct essential information for themselves (e.g. Bruner, 1961; Papert, 1980; Steffe & Gale, 1995). Others suggested that inexperienced learners should be provided with direct instructional guidance on the concepts; context and procedures required by a particular discipline and should not be left to discover those procedures on their own Cronbach & Snow, 1977; Klahr & Nigam, 2004; Mayer, 2004; Sweller, 2003).

The minimally guided approach has been called by various names including discovery learning (Anthony, 1973; Bruner, 1961); problem-based learning (PBL; Barrows & Tamblyn, 1980; Schmidt, 1983); inquiry learning (Papert, 1980; Rutherford, 1964); experiential learning (Boud, Keogh, ampersand Walker, 1985; Kolb & Fry, (1975), and constructivist learning (Jonassen, 1991; Steffe & Gale,1995).

Problem-based learning can therefore be regarded as an instructional approach by which students learn by tackling challenging, open-ended problems. The problems are authentic tasks and are solved in socially and contextually based domain among students

3. Research Design

This study employed a 2X2 pre-test, post-test quasi- experimental factorial design. The researcher uses control and experimental groups but does not randomly assign participants to groups (Creswell, 2009). A pre-test and post-test are administered to both groups, but only the experimental group receives the treatment. In this study a subject teacher from each of the schools received the training and was told the intervention strategy to be employed when teaching lexical ambiguity in algebra (PBL). The strategy was basically used to improve students' problem solving skills; the control group was used as the comparison group.

3.1 Population and Sample size (n) Justification

The population consisted of Grade 9 students in the East London district. The sample size consisted of two intact classes of grade 9 students from two schools within East London district with (109) learners as the research population (N). The schools were purposively selected, two classes for experimental and two for control. The sample consisted of (65) girls and (44) boys with an age range from 13 to 15 years. Hence the sample size was (109) respondents, where N is the population size. The sample size was relatively small in order to cater for the assumption of ANCOVA and for the reliability of the study results.

3.2 Instrument and Method of Data Collection

A quantitative research was employed, hence structured and adopted questionnaires were used to collect data. The researcher used the structured and adopted questionnaires as the data collection instruments for the study.

The instruments are Lexical Ambiguity in Algebra Performance Test (LAAPT), Method of Instruction Questionnaire (MIQ), and the (LAAPT) consisted of twenty multiple choice questions on algebra word problems which sought to test students' ability to interpret algebraic notation. They are content-based questions and the respondents were expected to work out mathematics problems answer some pertinent questions related to algebra learning The (MIQ) questionnaire sought to illustrate the problem students' encounter in mathematics and algebra lessons they contained a modified 5 point Likert scale. The respondents were required to circle the relevant scale. The other instrument PBL strategy, was introduced to make comparison between it and conventional method (CTM)

4. Results and Findings

H_0 1; There is no significant relationship between lexical ambiguity in algebra and grade 9 students' academic performance.

H_0 2: There is no significant relationship between method of teaching and students' academic performance.

Table 1: Relationship between Lexical Ambiguity in Algebra and grade 9 Students' Academic Performance

Variables	No Frequency	Mean	Std. Dev.	r	P
Lexical Ambiguity in Alg.	109	41.33	5.10	.422	0.05
Academic Performance	109	15.54	2.69		

The table1 shows the relationship between lexical ambiguity in algebra and the academic performance of the grade 9 respondents. The data suggests the absolute value near of .05 which is considered positive. This means that the two variables have strong tendency to cohere. This indicates that there is a significant relationship between lexical ambiguity in algebra and grade 9 academic performances. From the table, r = 0.422, and P> 0.05, the finding suggests that the lexical ambiguity in algebra does determine grade 9 students' academic performance; Hence, In order to determine the magnitude of achievement mean scores across the groups, the estimated marginal means of the experimental group and the control group are presented in the table below:

Table 2: Estimated Marginal Means for Students across the groups.

Treatment Groups		**Mean**	**Std. Error**
Exp. i (Pre-test)	27	.116	.720
Exp. ii (Post)	27	1.57	.714
Cont. i (Pre-test	28	.116	.726
Cont. ii. (Post-test)	28	.361	.714
Exp. Pre vs. Cont. Pre	55	.116	.726
Exp. Post vs. Cont. Post	55	.579	.735

Table2: reveals that the experimental group pre-test had the lowest adjusted mean score ($\bar{x}$ =.116; SE=.720) than the experimental group post-test ($\bar{x}$ = 1.57; SE =.714) and the control group pre-test ($\bar{x}$ =.116; SE =.726) is lesser than post-test ($\bar{x}$ = .361; SE =.714), while the experimental group pre-test and control group pre-test has ($\bar{x}$ = .116; SE =.726) and experimental group post-test and control group post-test has ($\bar{x}$ = .579; SE =.735).

Table 3: Group Statistics

	Groups	N	Mean	Std. Deviation	Std. Error Mean	R
ACAP	Exp. Grp	52	15.7115	3.56638	.49457	.530
	Cont. Group.	57	15.3860	1.50895	.19987	

The above table reveals a relationship between the academic performance of the experimental group ($\bar{x}$ = 15.7; SD =.3.57) and the control group ($\bar{x}$ = 15.39; SD =1.51) and r =.530. This implies that there is a significant relationship between the academic performance of the experimental and the control group. The homogeneity in scores of the experimental and the control group based on their performance in the lexical ambiguity in algebra performance test is displayed in the table

Table 4: Tukey Post-Hoc Multiple Comparison of Posttest Achievement across the Groups

Treatment	Mean score	Exp.	Control
Exp.	1.57		*
Control	.361	*	*

*pairs of groups significantly different at p<.05

The table 4: shows that the significant difference obtained in the Table is as a result of significant differences between Experimental groups and the Control groups. The implication is that the experimental group performed significantly better than the control group in lexical ambiguity in algebra performance test.

Table 5: Homogeneity of the Groups

Names of GRPS	N	Subset for alpha = 0.05
		1
Control Group Pre Test	28	15.1429
Exp. Group Pre test	27	15.2593
Control Group Post Test	29	15.6207
Exp. Group Post Test	25	16.2000
Sig.		.473

Means for groups in homogeneous subsets are displayed.

Table 5: reveals that there is a significant main effect of the experiment on students' posttest achievement scores in Lexical Ambiguity Algebra ($F_{(2,109)}$ = .926; p<.05). Therefore, the null hypothesis 1 is rejected. In order to determine the magnitude of achievement mean scores across the groups, the estimated marginal means of the experimental groups and control group are presented in Table 5:

H_0 2: there is no significant relationship between methods of Teaching and grade 9 students' academic performance

Table 6: Relationship between Method of Teaching and grade 9 Students' Academic

Variables	No Frequency	Mean	Std. Dev.	R	P
Method of Teaching	109	13.36	2.86	.764	0.05
Academic Performance	109	15.54	2.69		

Table 6: shows the relationship between language proficiency and grade 9 students' academic performance. The data suggests the absolute value near of .05 which is considered positive. This means that the two variables have a strong tendency to cohere. This indicates that there is a significant relationship between method of teaching and grade 9 academic performances in lexical algebra. From the table, the finding r = 0.764, and P> 0.05, is not consistent. This

suggests that the method of teaching does determine grade 9 students' academic performance in lexical ambiguity in algebra performance test hence the null hypothesis is rejected. In order to determine how the variables co-vary with each other an analysis of co-variance is computed in Table bellow.

Table 7: Tukey Post Hoc Multiple Comparisons on Method of Teaching

(I) Names of GRPS	(J) Names of GRPS	Mean Difference (I-J)	Std. Error	Sig.
Control Group Pre Test	Control Group Post Test	.35345	.75766	.966
	Exp. Group Pre test	-.93519	.77132	.620
	Exp. Group Post Test	.13000	.78687	.998
Control Group Post Test	Control Group Pre Test	-.35345	.75766	.966
	Exp. Grp Pre test	-1.28863	.76476	.337
	Exp. Grp Post Test	-.22345	.78044	.992
Exp. Grp Pre test	Control Group Pre Test	.93519	.77132	.620
	Control Group Post Test	1.28863	.76476	.337
	Exp. Group Post Test	1.06519	.79371	
Exp. Grp Post	Control Group Pre Test	-.13000	.78687	.998
	Control Group Post Test	.22345	.78044	.992
	Exp. Group Pre test	-1.06519	.79371	.538

The table above shows the result of comparison of the two groups on both the pre and post- test on method of teaching which is significantly different at p<.0

Table 8: Tukey Homogeneous Subsets Displayed on Method of Teaching Test Score

Names of GRPS	N	Subset for alpha = 0.05
		1
Control Group Post Test	29	12.8966
Exp. Group Post Test	25	13.1200
Control Group Pre Test	28	13.2500
Exp. Group Pre test	27	14.1852
Sig.		.350

Means for groups in homogeneous subsets are displayed.

The table shows that the significant difference obtained is as a result of significant differences between experimental groups and the control. The implication is that the experimental group performed significantly better than the control group in the method of teaching questionnaire and that accounts for their better performance in lexical ambiguity in algebra performance test.

5. Discussions of Findings

The findings revealed a significant relationship between method of teaching and students' performance. This became evident with the outcome of post-test in the experimental class after the intervention, the teacher incorporated in his teaching approaches to lexical ambiguity in algebra word problems... Students were engaged in the new innovative teaching on the use of PBL, which give room for learners to participate actively in class and appreciate the new idea. Therefore, there is need to introduce instructional intervention strategies for algebra improvement.

The study showed that in the experimental group, the teacher used the strategy introduced in the teaching of lexical ambiguity in algebra. The learner participated actively in the classroom pedagogy.

The findings indicated that the treatment received by the experimental group before the post-test had a great effect in their performance. The study also indicated that the improvement after the treatment means that the students were taught with the introduction of the new strategy which was presented in English.

The data generated in this study indicated that pedagogical and content-based training is very important in improving teachers' problem solving abilities. The main objectives of this research were achieved, namely the issue of lexical ambiguity in algebra which was discovered to be one of the difficulties of students,

This study confirmed the connection between language and mathematics; the intervention of this study was done in the English language. A variation of this can be for the teacher to explore their own challenges on the issue of language when solving lexical ambiguity in algebra.

6. Educational Implications

Teachers should be encouraged to create interest and understanding in the problem of language in mathematics through awareness. Also, everyday language and experiences should not necessarily be seen as obstacles to developing academic ways of communicating in mathematics. It is not ideal to dichotomize every day and academic language. Instead, teachers need to consider how to assist students in connecting the two ways of communicating by building on everyday communication and contrasting the two when necessary. In the discourse of mathematics we need to consider the spectrum of mathematical activity as a continuum rather than reifying the separation between practices in out-of-school settings and the practices in school.

Instead of debating whether an utterance, lesson or discussion is or is not mathematical discourse, teachers should rather explore what practices, inscriptions, and talk mean to the participants and how they can use them judiciously to accomplish their goals. Again, teachers need to divert their mode of instruction from monolithic views of mathematical discourse and dichotomized views of discourse practices and consider every day and scientific discourses as interdependent, dialectical and related, rather than assume they are mutually exclusive.

Hence, lexical ambiguity and multiplicity of meanings in everyday language should be recognized and treated not as a failure to be mathematically precise, but as fundamental to making meaning or sense of mathematical meanings and to learning mathematics with understanding. Consequently, mathematical language may not be as precise as mathematicians or mathematics or as mathematics teacher may imagine it to be.

7. Conclusion

This study explored the issue of lexical ambiguity in algebra together with method of teaching. The strategy for teaching was also discussed. This should provide an insight into some of the problems in the mathematics classroom. The idea generated should contribute to national and international academic debates on the teaching and learning of mathematics.

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