

Language Proficiency and Method of Instruction as Determinant of Grade 9 Students' Academic Performance in Algebra

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ABSTRACT In the recent time several studies have shown the relevance of language in the field of mathematics education and its impact on students' academic performance. Therefore, this study sought to investigate language proficiency, method of teaching as determinant of grade 9 students' academic performance in East London. A 2X2 pre-test, post-test quasi-experimental factorial design was adopted in the study. (109) subjects were involved in the study. The instruments adopted and structured for the study were Language of Instruction Questionnaire (LIQ); Method of Instruction Questionnaire (MIQ) Problem Based Learning Strategies in two parts (PBLSa) and (PBL Sb), Conventional Teaching Guide (C.T.G). 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 language determines students' academic performance ($r=0.773$; $P<0.05$); effect of the experiment on students post-test performance scores. Method of teaching is also said to be the determinant of students' performance ($r=0.764$, $P<0.05$). Hence, teachers need to keep abreast of current teaching methods and problem solving skills that can help to savage the downward trend in students' performance in mathematics across the globe.

INTRODUCTION

The past few decades have witnessed several studies among mathematics educators and researchers on the interrelationship between language and mathematics. Most of these debates pointed towards the same direction on the relevance of language in mathematics. It also pointed at its effects on students' academic performance. This has become a global issue. However, the main objective of this study was (1) to explore language proficiency in relation to algebra teaching and learning; (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.

It is worthy of note that the issue of language and mathematics cannot be over-emphasized, especially in a linguistically and ethnically diverse classroom like South Africa. 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 language proficiency and method of teaching on students' academic performance. Artigue and Assude (2001) 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. Herscovics and 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).

Statement of the Problem

There has been a trend of students' poor performance in algebra which has inspired researchers to gear research work in mathematics towards finding a solution to an aspect of mathematics. Hence, this study investigates the relationship between language proficiency, 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 language proficiency and students' academic performance in algebra.

However, no concrete effort has been geared towards the contribution of language proficiency, method of teaching, teaching strategies and performance 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.

Hypotheses

The following hypotheses were tested at 0.05 significant levels:

1. There is no significant relationship between language proficiency and grade 9 students' academic performance in Algebra
2. There is no significant relationship between method of teaching and grade 9 students' academic performance in Algebra

Language Proficiency and Academic Performance

In recent times there has been an increasing awareness of the relevance of language in mathematics pedagogy showing that mathematics is not devoid of language, but it is language-based. Yore et al. (2013) stated that language is an integral part of science education, a means of doing science and of constructing scientific understanding and meaning.

Studies have revealed that there is a close connection between proficiency in the language of instruction and students' understanding of mathematics (Barwell 2005; Setati 2002; Vorster 2008). Language proficiency is therefore related to learning ability and general academic achievement in mathematics (Cummins and Swain 1986). As a result of this conception of language and mathematics, many students are faced with the challenges of learning mathematics. Since Mathematics meaning is achieved through language, therefore, the language of instruction may be a barrier rather than a tool for communication and may contribute to low levels of mathematics achievement (Brock-Utne 2007).

Studies have shown that language is one of the stumbling blocks for mathematics understanding, especially for students learning mathematics in their second or third language. Mathematics is not "language free" and due to its particular vocabulary, syntax and discourse it can cause problems for students learning it in their second language at all levels of education (Barton and Neville-Barton 2003). Moschkovich (2010) also pointed out that by importing theories from linguistics, there is a danger of misreading and simplifying, and she stated that there is a difficulty in agreeing what is meant by 'language'. Cummins (1984) suggests that a certain level of linguistic proficiency seems to be in general necessary for academic achievement, but not language as such, but skills in a certain type of language.

According to Cummins (1984) there are two different types of language, both are related to thinking, one involved in social everyday interactions, and another one involved in decontextualized academic contexts, language for communication and the technical language.

Also, learners' language proficiency does not as such determine their performance in mathematics, as pointed out by Macgregor and Price (1999), who stated in their data that "there were a considerable number of students with high language scores and low algebra scores" (p. 456). Gaeilgeoirí students (who learn through the medium of Gaeilge) outperform monolingual students mathematically, once an appropriate proficiency in both languages has been achieved, students will perform well.

Some studies on immersion programmes have found positive correlations between learning mathematics in a second language and students' academic performance (Barwell, 2003; Bournot-Trites and Tellowitz 2002; Hart and Lapkin 2000; Williams 2002). Submersion programmes have established that bilingual students' perform low in mathematics when the school language is different from their home language (Adetula 1990; Adler & Setati 2000; Barton et al. 2005; Galligan 1995; Gorgorio and Planas 2001; Marsh et al. 2000; Secada 1992).

Boero et al. (2002) suggested that natural language plays an important role in mathematics learning because it functions as 'a mediator between mental processes, specific symbolic expressions and logical organizations in mathematical activities' (p.243). Boero et al. (2002) recommended that mathematics teachers mediate classroom instruction by building on students' individual construction and on natural models to help them attain a level of confidence in the use of natural language that will support their learning of mathematics.

Empirically supported theory in multilingual education pointed to a chain of mediating effects that language proficiency has on academic achievement (Guglielmi 2012). This means that an individual's proficiency in his first language promotes his English language proficiency, which in turn plays a vital role in his mathematical proficiency. Farrell (2011) said that students who are proficient in both their first and second language of instruction are better positioned to perform well in mathematics. Other studies such as (Lim 1998 cited in Yushau 2004) do not view the use of home language as a resource for learning mathematics. Howie (2001) corroborated with Lim (1998) by maintaining that the English language proficiency is related to performance in mathematics, particularly algebra word problems

In South Africa studies have identified code-switching as a strategy used by teachers and learners if they share common language to encourage conceptual discourse by allowing learners to speak informally about mathematics. (Chitera 2009; Setati 2008; Setati & Barwell 2006). While Adler (2001) noted an impasse that code-switching may deny learners access to LoLT, or that in choosing to use one home language speakers of other languages in the

classroom may be at disadvantage, invariably code-switching is not a compromise and cannot be officially promoted.

When a student lacks proficiency in the language of instruction, it becomes a disadvantage with respect to ability to listen with understanding and comprehend the written word; the student may not be able to express himself orally and in writing. (Chitera 2011; Morris 1978). To develop conceptual understanding of mathematical concepts and procedure in this sense, it means that performance in mathematics is influenced by the student's proficiency in the language of instruction (Zepp 1981). Miura (2001) argued that students' mathematics understanding is influenced by the cultural factors that form the representations that are found within the classroom. These factors include the characteristics of the language of instruction, and the characteristics of the mathematical terms that are specific to that language.

It is worthy of note that mathematical language has its own vocabulary, syntax, semantic and discourse properties. In terms of vocabulary, mathematics includes words that are specific to the domain (e.g. coefficient, denominator, etc.), and everyday words that take on a specific meaning within the context of mathematics (e.g. equal, rational, table, column, etc.). Competence in this specific vocabulary is crucial to students' mathematical understanding, especially as they progress to higher grades. It means that they have to learn the terms as they are related to the context in which they occur.

Learning to communicate verbally and in writing about mathematics is important and can be highlighted in the classroom by addressing correct use of vocabulary and grammar, encouraging the use of both written and spoken mathematical language, assisting with the translation of English phrases or sentences to mathematical language and, in general, encouraging students to discuss mathematics (Oldfield 1996). There are three types of activities students can engage in when performing mathematical activities: they must understand the language of the problem or the text; they must formulate the mathematical concept(s) required, and they must translate the concepts into mathematical symbols which they can manipulate for computational purposes.

Thus, correct problem solving and performance in algebra word problems can often be achieved through the identification of key words in the text and the words that link them (i.e. their referents). Hence, there is evidence that the use of key words to arrive at the proper

representation and solution of problems can be counterproductive because of the absence of context cues in mathematical notations. Therefore, mathematical thinking, mathematical proficiency, and mathematical practices are all closely linked to and dependent on language and communication.

Teaching Method and Students' Performance

The concern 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. .

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 (Mayer 2004; Shulman and 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 them (Bruner 1961; Papert 1980; Steffe and 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 and Snow 1977; Klahr and 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 (Barrows & Tamblyn 1980; Schmidt 1983); inquiry learning (Papert 1980; Rutherford 1964); experiential learning (Boud et al. 1985; Kolb and Fry 1975), and constructivist learning (Jonassen 1991; Steffe and Gale 1995). Problem-based learning (PBL) 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

Research Methodology

This study employed a 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 algebra (PBL). The strategy was basically used to improve students' problem solving skills; the control group was used as the comparison group.

Population and Sample

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 population 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 ensure the reliability of the study results.

Research Instruments

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 Language of Instruction Questionnaire (LIQ) Method of Instruction Questionnaire (MIQ), and the (LIQ) it contained a modified 5 point Likert scale which consisted of ten questions on language of instruction questions and the respondents were expected to answer some pertinent questions related to language and algebra learning. The (MIQ) questionnaire sought to illustrate the problem students' encounter in mathematics and algebra lessons it 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)

Validity and reliability of instruments

The content and face validity of the instruments was safeguarded by giving it to the experts in the field of mathematics, suggestions and corrections were effected to improve the instrument. The Kuder-Richardson's formula 21 was used to test the reliability of Language of Instruction Questionnaire (LIQ) and Method of Instruction Questionnaire (MIQ) in order to determine the internal consistency and reliability of each item. The value ranges from 0 to 1; high indicates reliability while two high a value (0.9) indicated a homogeneous test. Also, other instruments were measured using Crombach Alpha to measure the reliability co-efficient.

Data collection/analysis

There were two major instruments used for data collection. The instruments were administered personally by the researcher in each of the sampled schools with the help of some teachers as allocated by the school authority. The respondents signed the ethical consent forms where the purpose of the study has been clearly spelt out. Again, the items in the questionnaire and the performance test were sorted out according to the variables they were designed to measure. Data collected were analysed using Tukey Post Hoc Multiple Comparison.

Results and Findings

Hypothesis 1; There is no significant relationship between language proficiency and grade 9 students' academic performance in Algebra

(Insert table 1)

Table.1 shows the relationship between language proficiency and Grade 9 students' academic performance. The data suggest 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 language proficiency and Grade 9 academic performance. From the table, $r = 0.773$, and $P > 0.05$, therefore the finding is not consistent with the stated null hypothesis. This suggests that the language proficiency does determine Grade 9 students' academic performance in algebra; 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 below

(Insert table 2)

Table 2: above 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 language proficiency questionnaire and this account for their better performance in the test.

(Insert table 3)

Table 2 and 3 showed 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 by scoring higher than the control group in language proficiency questionnaire test.

Hypothesis 2; There is no significant relationship between method of teaching and grade 9 students' academic performance in Algebra

(Insert table 4)

The table above indicates that there is a significant relationship between method of teaching and grade 9 students' academic performances in algebra. From the table, the finding $r = 0.764$, and $P > 0.05$, is not consistent with the stated null hypothesis. This suggests that the method of teaching does determine grade 9 students' academic performance 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 below.

(Insert table 5)

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 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 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 below

(Insert table 6)

Table 6; shows that the significant difference obtained in Table 6 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 algebra performance test.

Discussion and Summary of Findings

The results of data analysis on the relationship between language proficiency and students' academic performance indicate that language proficiency is a major determinant of students' academic performance in algebra. These findings corroborate with Barwell (2005), Vorster (2008) and Setati (2002). They all stated that there is a close relationship between language proficiency and students' performance. Also, Moschkovich (2010), Gughelmi (2012) both concur with the result of this finding that proficiency in language of instruction determines academic performance. Farrell (2011) as well stated that language proficiency determines mathematics achievement.

The findings on method of teaching indicate that method of teaching does affect student' performance, this actually reflected in the result where the experimental group on whom the experiment was performed did much better than the control group.

This corroborated with Barrow and Tamblyn (1980) on the use of PBL as an instructional approach.

Conclusion

The result indicates that language is paramount in the study of mathematics especially the aspect of algebra which is language inclined. It means in the teaching and learning of algebra language should be taken cognizance off. The method of teaching also goes a long way in determining students' academic performance according to the finding, it also shows that no method is perfect but when students are allowed to make discoveries on their own it will improve their performance.

Recommendation

On the basis of the findings of this study the following are recommended;

1. Both the teacher and learners should have the understanding that the issue of language in mathematics is not meant to reteach English or hijack the work of an English teacher but to help students in thinking linguistically which is a prerequisite for thinking mathematically'
2. Mathematics teachers should always be ready to welcome new ideas and developments by being flexible which can actually help their teaching.
3. Curriculum planners should also work with mathematics teachers in order to tackle the linguistic aspects of mathematics that are problematic.

Implications for teaching and learning

The sample of students involved in this study is relatively small from which to draw generalizable conclusions about all grade 9 students in South Africa but it is considered that the findings reported here present a good description of language proficiency and its influence on performance of mathematics students in algebra. These students are in a particular situation of learning mathematics through the medium of English which is their L2. A number of implications and applications for the teaching and learning of mathematics can be suggested. These include the following: Performance on algebra problems is related to language proficiency. Therefore, students' proficiency in English should be assessed. This may be useful for teachers in order to identify students of high proficiency, as well as those who have low proficiency, so as to cater for their learning needs in mathematics. A significant relationship exists between their performance in Algebra and the teaching method, by adopting a teaching strategy like PBL the academic performance will improve.

Ethical issues

The researcher got permission to conduct research from the relevant authorities. The Faculty of Education, the University, District Education Office and the schools where the study was conducted. Consent forms were duly filled as the research respondents are minors. Thereby, the respondents had the freedom to make an informed decision about whether or not to participate in the study. Again, in order to protect the identity of the respondents and schools, pseudonyms was employed in the study. Respondents were also assured that the research is unlikely to negatively influence the relationship between learners and their teachers at the school. Moreover, respondents were assured of the confidentiality of the information provided in the course of the study.

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Table 1: Relationship between Language proficiency and Grade 9 Students' Academic Performance

Variables	NoF Frequency	Mean	StStd. Dev.	R	P
Language Proficiency	109	28.15		.773	0.05
Academic Performance	109	15.54			

Table 2: Tukey Post Hoc Multiple Comparisons on Language Proficiency Post Test

(I) Names of GRPS	(J) Names of GRPS	Mean Difference (I-J)	Std. Error	Sig.
Control Group Pre Test	Control Group Post Test	-3.57882*	1.31048	.037
	Exp. Grp Pre test	-.52646	1.33411	.979
	Exp. Grp Post Test	.65429	1.36101	.963
Control Group Post Test	Control Group Pre Test	3.57882*	1.31048	.037
	Exp. Grp Pre test	3.05236	1.32277	.103
	Exp. Grp Post Test	4.23310*	1.34989	.012
Exp. Grp Pre test	Control Group Pre Test	.52646	1.33411	.979
	Control Group Post Test	-3.05236	1.32277	.103

	Exp. Grp Post Test	1.18074	1.37285	.825
Exp. Grp Post Test	Control Group Pre Test	-.65429	1.36101	.963
	Control Group Post Test	-4.23310*	1.34989	.012
	Exp. Grp Pre test	-1.18074	1.37285	.825
*. The mean difference is significant at the 0.05 level.				

*pairs of groups significantly different at $p < .05$

Table3: Tukey Homogeneous Subsets Displayed on Language Proficiency Test Score

Names of GRPS	N	Subset for alpha = 0.05	
		1	2
Exp. Grp Post Test	25	26.5600	
Control Group Pre Test	28	27.2143	
Exp. Grp Pre test	27	27.7407	27.7407
Control Group Post Test	29		30.7931
Sig.		.815	.111

Means for groups in homogeneous subsets are displayed.

*pairs of groups significantly different at $p < .05$

Table 4: Relationship between Method of Teaching and grade 9 Students' Academic Performance

Variables	No of 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 5: 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. Grp Pre test	-.93519	.77132	.620
	Exp. Grp 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. Group Pre test	Control Group Pre Test	.93519	.77132	.620
	Control Group Post Test	1.28863	.76476	.337
	Exp. Grp Post Test	1.06519	.79371	
Exp. Group Post Test	Control Group Pre Test	-.13000	.78687	.998
	Control Group Post Test	.22345	.78044	.992
	Exp. Grp Pre test	-1.06519	.79371	.538

*pairs of groups significantly different at $p < .0$

Table 6: 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 Grp Post Test	25	13.1200
Control Group Pre Test	28	13.2500
Exp Grp Pre test	27	14.1852
Sig.		.350

Means for groups in homogeneous subsets are displayed.