The effect of code-switching in the teaching and learning of mathematics in College of Education

Doe Florence[1], Isaac Owusu-Darko[2], Ernest K. Ofosu[2], Belinda Owusu-Mintah[2], Henry Apoenchir[1]

[1]SDA College of Education, P. O. Box 18, Asokore-Koforidua, Ghana, West Africa
[2]Valley View University, Techiman Campus, P. O. Box 183, Techiman, Ghana, West Africa

A B S T R A C T
Multilingual speakers has observed a widespread trend of utilizing different utterances, this phenomenon is called code-switching. This is sometimes needed in teaching of mathematical contents. Switching between two languages in the context of learning is perceived by educators to be an effective communication strategy in transferring and clarifying mathematical concepts at all levels. This study investigated the impact of code-switch on the teaching and learning of mathematics in selected class of SDA College of Education level 100 students in Ghana, West Africa. Students were put into 3 classess under quasi-experiemnt for the teaching of seleceted mathematical concepts in Geometry, algebra and statistics. The teaching of these concepts were used for respective classes for language-based instruction of the content: Akan (L1), English (L2) and Code-switching. The data analyses constituted students observed scores from their post teaching test. We investigated whether mean differences exist among the trilingual teaching approaches. The results showed that; the code-switch used in mathematical instruction mean scores was found to be significantly better than Twi and the English languages mode of instruction respectively. We recommend the integration of code-switching teaching approach of mathematical lesson especially in African community schools where multilingual system exist.

*Isaac Owusu-Darko.
E-mail: iowusudarko@vvu.edu.gh

1. INTRODUCTION

The multilingual system of most African communities create a relative challenge in the mode of instruction of mathematical concepts in the formal curriculum implementation. The idea of code-switch has been a controversial issue even as at the colonial era. Code-switching as a matter of facts cannot be taken off the context of language in education policy.

Before the inception of formal education in Ghana in the name of white love (Adika, 2012), traditional education was carried out in Ghanaian indigenous languages in its informal context. With the introduction of formal education and the subsequent use of English as the medium of instruction, the indigenous languages were seen as "inadequate" with respect to instructional media (Phillips & Fossey, 2012, Bamgbose, 2000). Bilingual system of education in Ghana started with the establishment of formal education in Ghana which initiated with the castle schools

and was later moored by the Christian mission schools. This period is the pre-colonial period (1529-1925).

The first ever statute on the use of a Ghanaian language as a means of teaching in education was implemented (Afrifa et al., 2019) to facilitate the teaching and learning process. Ghanaian language was slated to be used as the medium of instruction only at the lower primary level, while English was to be used at the upper primary and above. The policy was reversed and became unstable when the administration of the country came under the jurisdiction of indigenous Ghanaians in 1957. Since then, the use of a Ghanaian language as the medium of instruction at the lower primary level has had an uncertain history, (Ameyaw-Akumfi, 2002). The successful implementation of the use of English as the medium of instruction in education and the abandoning of her indigenous languages in education was therefore contrary to this ideology. Does this policy truly help in the teaching and learning of mathematics? We investigate in this paper, the effect of this language based teaching strategy on students understanding of mathematics content using L1, L2 and code-switch.

Irrespective of the rule governing tis langaue policy in Ghana, teachers still code-swicth in the instruction process. Perharps, with all these richly far fetching experiences of the past may be accountable to why some teachers and learners of mathematics code switch in the instructional process. The language used in instruction should be a very key point of concern since this can affect learners' rate of understanding, (Maqbool et al., 2018). It is noted that language in which ones education is directed has a far reaching effect on the achievement of instructional and educational objectives at all educational levels. The effectiveness or otherwise of teaching and learning process at all level depends on whether or not effective interaction has taken place between the teacher and the learner and this is backed by the spychologycal imprints guiding the teacher and the learner, (Owusu-Darko et al., 2017).

Mathematics teaching and the Language of Learning and Teaching (LOLT) are therefore contentious issues in the Ghanaian Education system with respect to the continual pursuit for approaches that will enhance the increased theoretical teaching and learning of mathematics This study is therefore conducted with the aim of gaining more insight into the effects of code switching in the teaching and learning of mathematics in Ghanaian school system by taking SDA College of Education as the case study.

Despite the tremendous efforts of the government and the ministry of Education (MOE) to make the use of English language as a medium of instruction in the teaching and learning in Ghanaian schools, some teachers and students seams to continue to use or revert to their mothers language (L1). This is because Education serves the purpose of equipping an individual with what is necessary to be a productive member of the society hence must be properly and effectively carried out. The fact that education entails the impartation of knowledge and skills as well as awakening and developing the intellectual potentials of the learner underscores the point that, the role of language use in instruction is important. According to (Bhowmik et al., 2013), the effectiveness or otherwise of the teaching-learning process at whatever level is dependent on whether or not effective communication has taken place between the teacher and the learner.

The medium of instruction or the language in which education is conducted has far reaching consequences in all educational systems. The language in which education is conducted is the language in which basic skills and knowledge are imparted into the population, (Cummins ,2000). It is observed that the language in which education is conducted is very important as the selected language may enhance or impede the quality of education. Therefore, language is an important issue, especially in multilingual classrooms where we have children from different linguistic and

socio-cultural backgrounds. (Mavuru & Ramnarain, 2020)

The language of instruction can be a problem, especially when the content or concepts being taught do not have the learners' home language equivalence, on the hand, learning certain subjects, such as Mathematics, in English may be a problem for pupils who are deficient in the English language. In such two sided coined problematic Learning situation, instruction in the pupils' home language or supplementing English with the pupils' home language (code switching) may lead to a better understanding of the contents being taught. This is the underlying factor that triggers many researchers into finding out whether code–switching really has any significant impact in the achievements of learners especially in Mathematics, discussions on the occurrence of code-switch reveals that, it takes place unconsciously and automatically to serve a purpose which may or may not be beneficiary (Yaacob & Seth, 2018). A lot of this researcher's suggest that, code – switching could affects students' performance positively, notwithstanding these positive contributions, are we so sure that, code switching is not detrimental to students' competence in English? Is there no hidden curriculum in code switching that we might realize when it is too late? Because "language is the vehicle for communicating ideas and thoughts can't code switching prevent the needed fluency and proficiency in the language of instruction? perhaps the appellations of code-switching sung by early researchers only researched under the context of code switching, but this study seeks to delve further into looking at the actual mathematics teaching even based on the learners native language (L1) in addition to the code switching strategy through experimental designs to delve further into finding out whether this actually holds in selected Ghanaian societies

Reasons for code-swicthing during Mathematics teaching

Code switching is when teachers alternate between the mother language and the LOLT during the learning process (Chen, 2018). Setati and Adler (2002) explain "code-switching as switching by the teachers and learners between the LOLT and the learners" mother language". The definitions above emphasize that code switching is used by teachers and learners through the use of learners" mother language in conjunction with the LOLT during the learning and teaching process. Yeong et al., (2019) is of the view that, "code switching is an influential teaching tool that facilitates learning and teaching because it encourages learner involvement in the teaching and learning process". Teachers feel the need to facilitate understanding by encouraging more informal mother language use through teacher and learner code switching in the classroom. On the other hand, however, they are compelled to move lessons in the opposite direction towards more formal second language use so that they induct their learners into the genres of academic talk and writing in which the subject is expressed, textbooks are written and ultimately examinations are conducted.

Learning in one's own language grips various advantages for the learner, including increased access, improved learning outcomes, reduced chances of repetition and drop-out rates, and socio-cultural benefits (Zelime & Deutschmann, 2019). Code switching is a cherished communication strategy for learning mathematics contents. Studies done in other African nations showed that code switching promotes better learning and understanding of mathematics among African students, (Dowling & Krause, 2019; Nomlomo & Katiya, 2018). The conclusion drawn by their findings in African teaching of L2 revealed that teaching with local langauge gave better results in Mathematics achievement than teaching entirely in English.

Arguments for Using the Home Language

By definition, most Ghanaian students are ELLs in that they speak a local dialect at home but English is the only mode of instruction in the schools (Nguyen, 2020). Research has shown that the use of a child's first language in education enhances linguistic, cognitive, and academic achievement (Baker-Bell, 2020; Sibomana, 2020). Such findings may indicate that the poor academic performance in Ghanaian schools, especially in English proficiency, might be due to a lack of foundation in the child's local language for transfer to the second language (Owu-Ewie, 2006). In the initial stages of child schooling, most reading tasks are performed by listening; children advance in strong listening skills and implicatively tend to hold on to those skills even in the later stages of schooling. It is difficult for the Ghanaian child, who is not proficient in English to begin with, to develop such listening skills to aid in reading comprehension proficiency. In addition, young children lacking English language vocabulary can lose interest in education at a critical point of their life.

In Ghanaian society, children with English language as their first language perform better academically than students encountering English at the start of school. This is because the latter group must overcome deficiencies in English while simultaneously maintaining academic progress with students already proficient in English, and many do not succeed (Fry, 2007). However, speaking a parent's native language other than English at home can have a positive effect on children's English literacy development, and bilingual language skills can positively affect children's educational achievement when the student's linguistic and cultural strengths are not overlooked. Current research indicates that speaking a native language at home in the elementary school years has positive effects on high school completion.

The discussion about the school policy on educators choice of language to teach was aimed at determining whether this policy was in alignment with the natural policy. The national school policy is supported by (Merisi & Pillay, 2020) who notes that, schools should create a school language policy in line with the national school policy where a positive school environment towards English (LOLT) is promoted. Even though the LOLT of Ghanaian Colleges of Education is English it is not strictly adhered to since teachers and learners sometimes code switched when necessary. The Western Cape education Department (WCED) states that, it is crucial that all learners gain competence in the language of assessment (LOLT) in order to be able to understand it and to write and use it effectively. Similarly, Setati and Adler (2000:225) observe that, teachers should induct their learners into mathematical English and hence it is crucial to use English in the mathematics classroom as much as possible. English language learners have the opportunities to broaden their vocabulary, knowledge and develop strong reading compression skills when actively engage with abundant texts (Wollman-Bonilla et al., 2008; Cummins, Mirza and Stille, 2012).

2. METHOD

The study used experimental design under quasi-experiment to demonstrate whether language mode of teaching mathematics proofs futile understanding of content taught. The study considered putting students into treatment classes to under-study seleceted mathematical content in Geomtry, algebra and statistics where respective classes were taught mathematical content using Akan-Twi local language (L1), English Language (L2) and code-switching strategies.

The population consisted of SDA College of education level 100 Primary group in Ghana. A total student of about 244 from early childhood teacher education class were cencusly considered. Students consisted three classes in all. Paired classes were balloted to consistitute control and experimental group. Mathematics education tutors with common qualification and ranks taught

these classes with regular English formal teaching communication and the other experimental group with code-switch whiles the other class were taught with the Language one (L1). Results of the pretest and post test were analysed for the study under various descriptive and inferential statistical assumptions.

3. RESULTS AND DISCUSSION

Students preinterventive scores and post teaching scores were analysed under descriptive and inferential statistics at significance level of 5%. Students were taught selected mathematrical concepts at level 100 with various classes under quasi experiment. Student were taught with English Language, Akan (Twi) and code-swicthed withing the sleceted classes. Results wre analysed under comparative significance mean difference under t-test assumption with population means assumed equal or unequal respectively.

Table 1 below presents the general statistical summary of the test scores of students under various treatment conditions. The total number of students for each treatment variable (N) is stated with their means which describes the average standing of the test scores, standard deviation describing the extent to which the a selected test score deviate from the mean and the skewness and standard error of skewness are equally computed.

Table 1: **Descriptive Statistics of students' scores**

	N	Mean	Std. Deviation	Skewness	Kurtosis
	Pop size	Statistic	Std. Error	Statistic	Statistic
Local Language (Akan)	81	49.3871	2.54062	1.57779	-.333
Code-Switch	82	52.6452	1.55857	-0.67774	.185
English Language	81	45.5161	1.54702	3.61344	1.718
Valid N (list wise)	244				

We test the hypothesis under studentized t-distribution with descriptives statistics in table 1. The analyses consider whether there exist mean differences in the performance of students in various teaching treatments methods (teaching with Local Akan language, Code-swicth or use English language). The selected three (3) classes were put into different population unit; the class taught with Akan-L1 (comprising 81 students), Code-switch (comprising 82) and English Language (comprising 81 students) respectively. Local language (Akan), code-switch and English language recorded means of 49.3871%, 52.6452% and 45.5161% respectively. The analysis of means, reveal a marginal differences in population means. Evidence of skewness measure gives a negative coefficient for code-switch class scores showing average performance of students above the mean. Treatment class taught selected mathematics concept with code-switch recorded a higher means as compared to other teaching language modes. We test wether the difference is significant in table 2 and 3 under studentized t-distrbution.

Figure one below gives the normality assumption of test scores of some selected classes taught with the different treatment language modes.
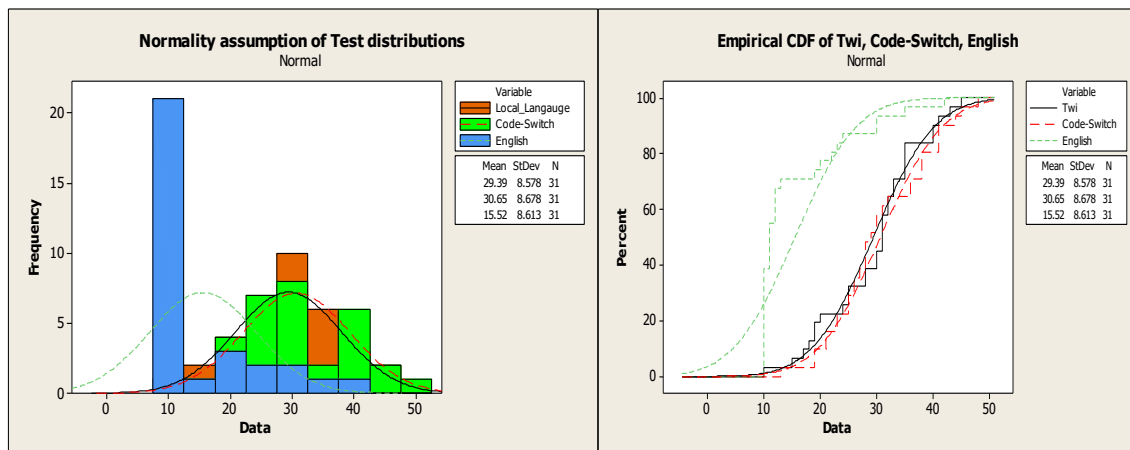
Figure 1: Noramality assumption of treatment means and emperical cdf

The distribution is fairly standard normal for Local language and coed-swicth post test scores. Students test score interpretation from English class teaching shoed a positive trend of weaker performance. From figure 1 above, it is clear that the normality distribution of the local language Twi and coed-swicth are quiet normal since it has few students performing poorly. The normality assumption of treatment 3, English language is clearly seen to be positively skewed indicating poor performance with majority of students within the failing class with very low mean score.

This discussion therefore suggest that, mathematics teaching and learners produce the best results when instructed using the code-switch strategy, this is because, students who are deficient in the English language are still unable to make up mathematical concepts when instructors code-switch hence improve learners performance. Also, using the local dialect of students produced better results as compared to the English language (evident from table 1) because learners learn conveniently mathematical concepts since there is meaningful communication of concepts learnt. Using the English language as a medium of instruction evident from table 2 recorded the poorest results which suggest that, most of mathematics learners level of education have very poor vocabulary in English which makes it very difficult to fathom basic mathematical concepts as compared to English based instructional teaching and learning of mathematical concepts.

When the mathematical concepts under discussion, do not have their equivalence in the local dialect or better still, if the instructor in question lacks the needed proficiency to break the mathematical concepts to the simplest understanding of learners, then learners risk the chances of losing concepts understanding and therefore resorting to route learning, (Herawaty et al., 2019). This has created the limitation of properly using the local Lnaguage as the sole medium of communication in the the teaching and learning of mathematics. To (Gerdes, 1997; Panzavecchia & Little, 2020), mathematical content becomes too whitich and Eurocentric when deficiency exist at a point when local langague can not be used to explain formal mathematics content. this has allowed the mathematical content learnt in the current curriculum to be looked at as whitish and eurocentrics in nature.

Figure 2 below gives selected individual plot for classes taught with different treatment languages modes: Local Langauge with blue trend, Code-swicth with red and English Language with green trends respectively.
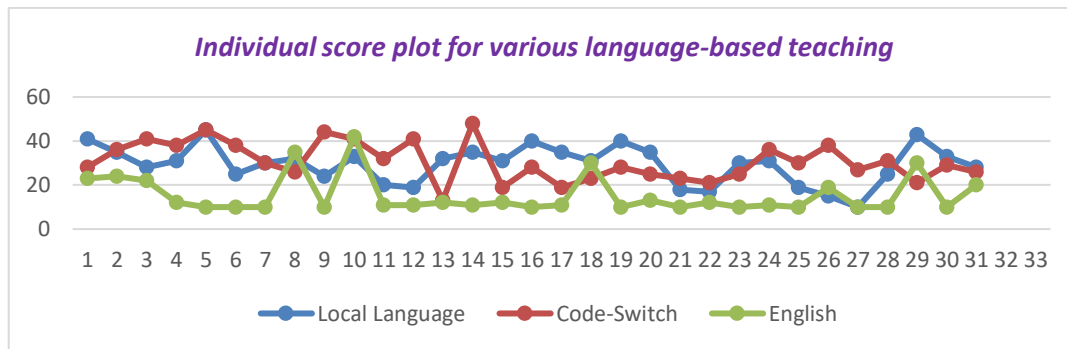
Figure 2; individual score plot for various language-based teaching

The trend plot for the three langauge mode of lesson delivery from figure 2 revals a least mean score trend for English class performance. Student performance are favoured and influenced when teaching with the codeswitch and Local L1 langauges respectively. Highest peak of the performances is from Code-switch class scores.

From all tables and graph discussed discussed so far, it can be inferred that, code-switch and the Twi local language nearly produced the same results, evident from their means. This implies that, using the code English language as a medium of instruction has the most effective impact on students' understanding of mathematical concept taught.

We then test the an inferential statistics on a research question whether there is any significant mean difference in the performance of students when taught mathematics with their local dialect, English language and code-switch. We compare significance mean difference using the language modes as the interaction effect on students understanding under Fisher one way F-test statistics:

$$\text{F- Statistic} = \frac{Adjusted\ mean\ square\ of\ treatment}{adjusted\ mean\ square\ of\ error} = \frac{\mathbf{SStr}/(\mathbf{t-1})}{\mathbf{SSe}/(\mathbf{n-t})}$$

At a significant level of $\alpha = 0.05$, we test the hypothesis that,
$$H_0; \mu_1 = \mu_2 = \mu_3$$
$$H_1; \mu_1 \neq \mu_2 \neq \mu_3$$
(At leat one of the treatment means are equal)

Table 2: One-way ANOVA for all teaching modes

Source	Df	SS	MS	F	P
Factor	3	4369.7	2184.8	29.38	0.000
Error	241	6692.2	74.4		
Total	244	11061.9			

S = 8.623 R-Sq = 39.50% R-Sq(adj) = 38.16%; Pooled StDev = 8.623

We Test for equality of means using the F- test. To investigate whether mean different exist for the performance of students in mathematics lesson based on the different mode of teaching using local L1, codeswitch or English languages. An estimate of f-test statistics 29.38 was tested to be significantly different in the means of the various performances at $\alpha = 0.05$.

Adjusted mean square of treatment 2184.8 and adjusted mean square of errors 74.4 gave an F-value of 29.38 are significant at 0.05. We investigate the Research question whether code-switch has any significant effects on the teaching and learning of mathematics the college of education

taught. The f-test statistics revealed a significantly mean difference between the means of students average performance in Code-switch class and English. A further inferential decision is tested in table 3 under the assumption of Levenes test for equality of means for English and code-swicthing treatment means. We assume for equalty of means and non-equality of means respectively at $\alpha = 0.05$

Table 3; Levene's test for equality of variances (English and code-switch)

	Levene's Test for Equality of Variances					t-test for Equality of Means		
	F	Sig.	T	df	Sig (2tailed)	Mean Diff	95% Confidece Interv	
							Lower	Upper
Comparative mean Difference between Performance of students in teaching with English and Code-Switch	*Equal variances Assumed*							
	.073	.788	-6.889	243	.000	2.1960	-19.5268	-10.638
	Equal variances not assumed							
	6.889	59.997	.000	241	.101	2.19600	-19.52169	-10.738

Levene's test for equality of variances (English and Local Language-Twi)

	Levene's Test for Equality of Variances					t-test for Equality of Means		
	F	Sig.	T	df	Sig (2tailed)	Mean Diff	95% Conf Interval	
							Lower	Upper
Comparative mean Difference between Performance of students in teaching with English and Local Language	*Equal variances Assumed*							
	0.73	.001	0.972	243	.000	12.196	-19.521	-10.736
	Equal variances not assumed							
	6.353	0.023	59.999	219.97	.0101	2.1800	-18.231	-9.503

We compared the means of the two mean treatments for performances using paired sample t-test for different population means. The distribution reveal a significant test of means difference for equal variance whilst is insignificant at non-assumption of equal variance. Implicatively, the treatment classes has equivalent ability levels with similar entry requirements, common standard but experience different mode of instructional language teaching of mathematics. From table 3, the F-value produced by the Levene's test comparative of mean differences between English language and code-switch instruction based scores is 0.73 for the selected treatment class for assumed equality of variances and for non-assumed equality of variances at α-level of 0.05.

Evidence from the tables and discussions reveals that, the variability of test scores from all treatments conditions is the same. This suggest that, the code-switching strategy used in mathematics instruction has a significant effect on the teaching and learning process. We therefore fails to reject the null hypothesis that, *code- switch has no significant effect on the teaching and learning of mathematics in seleceted class taught in the College of Education*.

4. CONCLUSION

Bilingual language code-switching in mathematics teaching, whether it influences students understanding of mathematical concept taught was looked out in this study. This code-switching strategy considered a situation by which mathematics teacher tries to explain mathematical concepts in problem solving strategies by bridging the gap between L1 and L2. A sample size of 244 students (comprising three classes 81, 82 and 81) under three treatments (T$_1$, T$_2$ and T$_3$) for

selected language mode of teaching in a quasi-experiment was considered for the study. The focus of the study was to investigate whether teaching mathematics selected concepts with English (L1), Local Language language-Akan (L1) and code-switching will bring different performance output. The study reveals a significant mean difference between the three treatments (30.645, 29.387 and 15.516) at 5% significant level ($\alpha = 0.05$).

From the findings, we conclude on a significant effect of code-switching in the teaching and learning of mathematics since this is reflective in imfluencing student understanding of the mathematical concepts taught. The second language (English) when used entirely for the teaching of the mathematical lesson, triggers a lot of misunderstanding. The use of their Local Language (Akan) however good in teaching and understanding, but is limited in its bilingual literal translation of basic mathematical terms associated with the content elements.

Recommendations

We recommend that, Educational policy makers should accept the code-swicth approach in teaching all level of the learner education most especially, among African communities were multilingual system exist. Langauge Policies regarding the teaching and learning should consider the local language of the learner and accept the code-switch study in the instructional process of the learner education.

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