academicresearchJournals

Vol. 2(7), pp. 152-159, August 2014
DOI: 10.14662/IJARER2014.035

ISSN: 2360-7866©2014 Academic Research Journals
http://www.academicresearchjournals.org/IJARER/Index.htm

International Journal of Academic Research in Education and Review

Full Length Research

Relationship Between SMASE-Trained Teachers' Factors and Primary School Pupils' Mathematics And Science Achievement in Murang'a County, Kenya

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Accepted 4 August 2014

This study investigated the relationship between SMASE-trained teachers' factors and pupils' achievement in Mathematics and Science in primary schools in Murang'a County. Correlational research design was adopted in this study. Stratified random sampling was used to ensure that rural and urban schools in the County were represented. One hundred and nine teachers participated in the study. Four research instruments that included teachers' questionnaire, a lesson observation guide and two achievement tests, one in Mathematics and the other in Science, were used in the study. Chi square and Pearson Correlation Coefficient were used to test the null hypotheses (α =.05). The study found that SMASE-trained teachers' gender, teaching experience and level of application of SMASE skills were not significantly related to students' academic achievement.

Key words: SMASE skills, gender, teaching experience, level of application, classroom practices.

INTRODUCTION

The international community's commitment over quality in education at the basic level of education has been emphasized in many international protocols including the World *Conference on Education for All (1990) and the Dakar Declaration on Education for All* (2000). Further, in the past few decades, educational planners, policy makers and administrators have become increasingly aware that many meaningful improvements in the quality of education offered to pupils are highly dependent on the quality of teachers (Chhinh and Tabata, 2003; Kimani, Kara and Njagi, 2013). Therefore, researchers have in the recent past shown profound interest in teacher-related factors that influence pupils' achievement (Adediwura and Tayo, 2007; Tatto and Senk, 2011). Some of the teacher-related factors found to influence pupils' achievement include teachers' gender, teaching experience and teaching practices related to attendance of professional development courses.

In relation to teachers' gender, research has established a relationship between teachers' gender and pupils' performance. Ammermuller and Dolton (2006) found that there were some positive joint pupil-teacher gender interaction effects in the teaching of Mathematics in England. Further, Park and Hannum's (2001) research in rural China quoted in Adams (2012) established that, Mathematics test scores were higher when the gender of

Table 1: Year 2010, 2011 and 2012 KCPE Mean Scores in Mathematics and Science for Selected Districts in Murang'a County, Kenya

Mean Scores (%)						
District	**Mathematics**			**Science**		
	2010	2011	2012	2010	2011	2012
Kigumo	48.8	46.7	49.2	47.5	46.4	48.1
Murang'a East	49.3	50.2	49.9	48.2	48.5	49.9
Mathioya	46.2	46.4	47.4	46.2	45.5	47.1
Gatanga	45.7	45.9	45.5	45.6	45.0	43.0
Kandara	47.3	47.8	46.2	46.5	46.9	44.3
Murang'a South	48.5	48.3	46.7	48.1	46.4	44.4

(Sources: District Education Offices, Murang'a County)

the teacher and the students were the same.

Teachers' experience is another variable found to influence pupils' achievement. Although Adams (2012) contends that understanding teacher characteristics, particularly teaching experience and student achievement presents numerous challenges, several studies seeking to establish the relationship between teaching experience and pupils' achievement have been done (Olaoye, 2012; Yala and Wanjohi, 2011; Adeyemi, 2010; Hawkins, Stancavage and Dossey, 1998). For instance, Yala and Wanjohi (2011) contends that teachers' experience is a prime predictor related to students' achievement.

Teachers' attendance of professional development courses and application of skills learnt in in-service courses is another factor of interest in studies relating to students' achievement. However, there is mixed evidence on the effect of teachers' participation in professional development activities on students' learning outcomes. On the one hand, there are studies which found no effect of professional development courses on pupils' achievement (Angrist and Lavy, 2001; Jacob & Lefgren, 2004). On the other hand, some studies have established that higher levels of student achievement were linked to participation in content-specific in-service pedagogical activities and programmes (Wiley and Yoon, 1995).

In the endeavour to improve pupils' achievement in Mathematics and Science, the Government of Kenya embarked on the implementation of Strengthening of Mathematics and Science Education *(SMASE) in-service training programme for Mathematics and Science teachers in primary schools in* 2009 (Republic of Kenya, 2008). It was envisaged that after SMASE training, teachers would adopt ''Activity, Student-centred, Experiment, Improvise (ASEI) and Plan, Do, See, Improve (PDSI)'' approach in the teaching of Mathematics and Science and that this approach, would result in enhanced pupils' learning outcomes.

Statement of the problem

Mathematics and science are not only compulsory but also important subjects in the Kenyan primary school curriculum and their crucial role in the realization of Kenya Vision 2030 cannot be underestimated (Government of Kenya, 2007). In line with this, the Kenya government in collaboration with donor agencies has consistently implemented teacher-based educational interventions aimed at improving pupils' achievement in mathematics and science in primary schools. These interventions include; Strengthening Primary Education (SPRED) programme, School-based Teacher Development (SbTD) programme and recently, the Strengthening of Mathematics and Science Education (SMASE) programme (Republic of Kenya, 2008: CEMASTEA, 2010, SMASE-WECSA Association, 2010). Despite implementation of these teacher-based interventions, pupils' achievement in Mathematics and Science in primary schools in majority of the districts in Murang'a County has remained far below stakeholders' expectations. Table 1 presents mean scores for Mathematics and Science posted by six out of the eight districts in 2010, 2011 and 2012 KCPE results. Although there was improvement in mean scores for both Mathematics and Science in some districts in Murang'a County, performance in the two subjects dropped in majority of the districts in 2011 and 2012. The downward trend of pupils' performance in Murang'a County has raised concerns both at the national and at the county levels.

According to Murang'a County Government (2013), the declining educational trend in primary schools in Murang'a County is an issue of concern to the county

stakeholders. Poor performance of primary schools in Murang'a County undermines pupils' chances of joining highly performing secondary schools and this subsequently jeopardizes their future employment opportunities, participation in the national economic development and poverty alleviation. This study therefore sought to analyze the relationship between SMASE-trained teacher factors and pupils' achievement in Mathematics and Science in primary schools in Murang'a County.

Objective of the study

The objective of this study was to determine the relationship between SMASE-trained teacher factors and pupils' achievement in Mathematics and Science in primary schools in Murang'a County, Kenya.

Hypotheses of the study

The following null hypotheses (Ho) were tested in this study:

1. There is no significant relationship between SMASE-trained teachers' gender and pupils' achievement in Mathematics and Science.
2. There is no significant relationship between SMASE-trained teachers' experience and pupils' achievement in Mathematics and Science.
3. There is no significant relationship between teachers' level of application of SMASE skills and pupils' achievement in Mathematics in Science.

Theoretical Framework

This study was hinged on Fullan's (2001) model of educational change as discussed in his book, The *New Meaning of Educational Change. In his model of educational change, Fullan attempts to explain* a tripartite structure for understanding how educational change works. In this model, Fullan posits that there are three components or dimensions that are at stake during the implementation of any educational change: the possible use of new or revised materials; the possible use of new teaching approaches; and, the possible alteration of beliefs. According to Fullan, an individual may implement none, one, two or all the three dimensions. This assertion implies that teachers do not uniformly implement educational interventions.

Conceptual framework

Figure 1 shows the various variables related to the relationship between SMASE-trained teachers' variables and pupils' achievement in Mathematics and Science in primary schools. According to Kimani, Kara and Njagi (2013), the teacher as an input is the principal factor in education provision and thus affects the quality of education in a significant way. The independent variables are: SMASE trained teachers' gender; teaching experience and teachers' level of application of SMASE skills. These variables form the input to the teaching and learning process during which SMASE-trained teachers are expected to apply SMASE skills. According to Republic of Kenya (2008), implementation of the SMASE in-service programme was aimed at transforming teachers' classroom practices with the ultimate goal being to strengthen pupils' achievement in Mathematics and Science. This study therefore sought to establish the relationship between SMASE-trained teachers' factors and pupils' achievement in Mathematics and Science in primary schools in Murang'a County.

METHODOLOGY

This study adopted the Ex post facto research design. Stratified random sampling was applied to ensure that rural and urban schools in the County were represented in the sample. According to Republic of Kenya (2008), every public primary school was expected to identify three teachers teaching Mathematics and Science in standard six, seven and eight to undergo SMASE training giving a total sample of 1170 teachers of which 10 per cent (117) teachers were sampled for the study.
A response rate of 93.2 per cent (109 teachers) was achieved. Lesson observations were done in 19 schools.

The researcher designed and validated four instruments to collect qualitative and quantitative data. These instruments included teachers' questionnaires, a lesson observation schedule and two achievement tests in Mathematics and Science. Each test contained 30 multiple choice questions covering the primary school Mathematics and Science syllabi. The lesson observation schedule had two parts with Part A having nine items capturing teachers' background information. Part B had six items capturing various aspects which included; use of teaching-learning resources, use of improvised teaching-learning resources, pupils' involvement in class discussions during the lesson, pupils' involvement in practical activities, teachers' use of learner-centred approaches and content mastery on the part of the teacher. Teachers' application of these aspects were rated using the following options: 1- Very Low (VL), 2-Low (L), 3-Satisfactory (S), 4-High (H) and 5- Very High (VH). Descriptive and inferential data analysis techniques were used in this study. Descriptive statistics such as percentages, means and standard deviations were calculated mainly in the analysis of pupils' achievement

tests and the demographic information obtained from teachers. Testing of null hypotheses was done using the Chi Square (χ^2) test and Pearson correlation coefficient r. The .05 level of significance ($\alpha = .05$) or 95% confidence level was used in rejecting or accepting the null hypotheses.

RESULTS

This study sought to establish the relationship between SMASE-trained teacher factors and pupils' achievement in Mathematics and Science. In the sample taken, male teachers accounted for 52.3 per cent while female teachers were 47.7 per cent. All the teachers who participated in this study had attended various cycles of SMASE INSETS. Almost half of the teachers (49.5%) had a teaching experience of 21-30 years followed by those who had experience of 11-20 years who accounted for 32.1 per cent. Those who had experience of less than 10 years were 7.4 per cent. Teachers with experience of over 31 years were 11.0 per cent. This finding shows that teachers with varying experience attended SMASE training sessions.

SMASE-trained Teachers' Gender and Pupils' Achievement in Mathematics and Science

The first null hypothesis (Ho1) stated that, there is no statistically significant relationship between SMASE-trained teachers' gender and pupils' achievement in Mathematics and Science. The dependent variable for Ho1 was the school mean score. The subject mean score was obtained by calculating the average from the total scores obtained by the pupils in each achievement test. The independent variable was SMASE-trained teachers' gender- a nominal variable with two values, that is, male and female. Analysis of the relationship between SMASE-trained teachers' gender and pupils' achievement in Mathematics and Science was done using Chi Square (χ^2) tests performed using the SPSS computer software.

Chi Square test for the first part of the null hypothesis (Ho1) which stated that there is no statistically significant relationship between SMASE-trained teachers' gender and pupils' achievement in Mathematics yielded a χ^2 value of 16.806 which was not statistically significant at .05 level of significance ($\chi^2 = 16.806$; $p = .331$). Consequently, Ho1 was accepted; indicating that there was no statistically significant relationship between SMASE-trained teachers' gender and pupils' achievement in Mathematics. Chi Square test for the second part null hypothesis which stated that there is no statistically significant relationship between SMASE-trained teachers' gender and pupils' achievement in Science yielded a result that was not statistically significant at .05 level of significance ($\chi^2 = 16.474$; $p = .285$). Consequently, this null hypothesis was accepted; meaning that there was no significant relationship between SMASE-trained teachers' gender and pupils' achievement in science. Therefore, Chi Square analysis yielded no relationship between SMASE trained teachers' gender and pupils' achievement in the two subjects.

SMASE-trained Teachers' Experience and Pupils' Achievement in Mathematics and Science

The second null hypothesis (Ho2) stated that there is no statistically significant relationship between SMASE-trained teachers' experience and pupils' achievement in Mathematics and Science. Pearson correlation coefficient (known as Pearson's r) was used in testing the null hypothesis. Pearson's r for Ho2 was -.078; which was not statistically significant at .05 level of significance ($r = -.078$; $p = .211 > .05$). These results showed that there was a weak statistically insignificant negative correlation between SMASE-trained teachers' experience and pupils' achievement in Mathematics.

Further, Pearson's r obtained for the second part of the second null hypothesis (Ho2) which stated that there is no statistically significant relationship between SMASE-trained teachers' experience and pupils' achievement in Science was .004 ($p = .484$). These results indicated that there was no statistically significant relationship between SMASE-trained teachers' experience and pupils' achievement in Science. The above results prompted acceptance of Ho2. Acceptance of Ho4 meant that SMASE-trained teachers' experience had no significant relationship with pupils' achievement in Mathematics and Science.

Teachers' Level of Application of SMASE Skills and Pupils' Achievement in Mathematics and Science

The third null hypothesis (Ho3) stated that there is no statistically significant relationship between SMASE-trained teachers' level of application of SMASE skills and pupil achievement in Mathematics and Science. Teachers' levels of application of SMASE skills were established through lesson observations. Lesson observations involved rating of teachers' application of various SMASE aspects using a Likert scale which had the following options; 1-Very Low, 2-Low, 3-Satisfactory, 4-High and 5-Very High. The areas that were rated included; use of teaching-learning resources, use of improvised teaching-learning resources, pupils' involvement in class discussions during the lesson, pupils' involvement in practical activities, teachers' use of learner-centred approaches and content mastery on the

part of the teacher.

The rating process was systematically done as the lessons progressed. These ratings were carefully captured in the lesson observation schedules. Then a post-rating analysis was done whereby a mean rating for each teacher in each subject was calculated to indicate the teachers' level of application of SMASE skills in the subjects. The values for teachers' level of application of SMASE skills during Mathematics lessons ranged between 2.6 (rated as satisfactory) and 4.0 (rated as high). The rating scale had values between 1.0 and 5.0 with mean values of 1.0- 2.4 implying low level of application; 2.5 and 3.4 showed satisfactory level of application and mean values of 3.5-5.0 showed high level of application of SMASE skills. Further analysis of teachers' levels of application of SMASE skills during Mathematics lessons showed that about half of the teachers (52.6%) had levels of application that ranged between 2.6 and 3.4 which translated to ''satisfactory'' level of application. The rest of the teachers (47.4%) had level of application that ranged between 3.6 and 4.0 which translated to ''high'' level of application.

On the other hand, analysis of teachers' levels of application of SMASE skills during science lessons showed that levels of application ranged between 2.9 (rated satisfactory level of application) and 4.0 (rated high level of application). It was noted that there was very little variation between teachers' level of application of SMASE skills during Mathematics and Science lessons. Pearson's r for teachers' level of application of SMASE skills and pupils' achievement in Mathematics was - .177 ($p = .234$).

These results depicted a statistically insignificant negative relationship which prompted acceptance of Ho2. This implied that SMASE-trained teachers' application of SMASE skills had no statistically significant relationship with pupils' achievement in Mathematics.

Pearson's r for the relationship between SMASE-trained teachers' level of application of SMASE skills and pupil achievement in Science lessons was .066 ($p=.395$). These results pointed to a statistically
insignificant weak positive relationship between the two variables. On the basis of these results,
Ho3 was accepted; implying that SMASE-trained teachers' level of application of SMASE skills had no significant relationship with pupils' achievement in both subjects.

DISCUSSION

This study analyzed the relationship between SMASE-trained teachers' factors and pupils' achievement in Mathematics and Science in primary schools in Murang'a County. The study found that there was no statistically significant relationship between SMASE-trained teachers' gender and pupils' achievement in Mathematics and Science. This observation may be attributed to the fact that SMASE programme has been under implementation in Kenyan primary schools for a relatively short period of four years. Therefore, it was unlikely that SMASE-trained teachers of either gender had adopted and implemented the ASEI-PDSI approach in a manner that had any major effects on pupils' achievement within the relatively short period; considering teachers' tendency to resist change as noted by Zimmerman (2006). The findings of this study seem to contradict Adams (2012), Okoro, Ekanem and Udoh (2012), Ammermuller and Dolton (2006), Dee (2006) and Smith (2004) who had established a relationship between teachers' gender and pupils' achievement.

However, the findings of this study are similar to those of other studies. For instance, Antecol, Erren and Ozbeklik (2012) studied the effects of teacher's gender on the primary school pupils' Mathematics test scores. In their study, these authors established no relationship between teachers' gender and pupils' learning outcomes. The same had been established in USA by Ehrenberg and Brewer (1995). Further, Holmund and Sund (2005) did not support the idea that a same-sex teacher had a positive causal impact on students' outcomes. The same findings were supported by Krieg (2005) who also found no evidence to support the hypothesis that the interaction of students' and teachers' gender impacted upon test scores. Kimani, Kara and Njagi found no relationship between teachers' gender and secondary school students' academic achievement.

This study further established that SMASE-trained teachers' experience had no statistically significant relationship with pupils' achievement in Mathematics and Science. The possible explanation for this finding is that although the introduction of SMASE programme aimed at transforming teachers' classroom practices from the traditional, authoritarian and teacher-centred approach to the participatory student-centred ASEI-PDSI approach, experienced teachers may have been trained in, and therefore accustomed to the traditional approach, whereby the teacher is the centre of the learning process. Therefore, SMASE-trained teachers' past teaching experience may not bring about meaningful effects on pupils' achievement. Acording to Goodson (2006) cited in Webster, McNeish, Scott, Maynard and Haywood (2012), older teachers often experience a sense of loss at the ending of established ways of teaching. The findings of this study seem to agree with those of Ravkin, Hanushek, and Kain (2005) who found no relationship between students' academic achievement and teachers' experience.

Further, it was established that SMASE-trained teachers' level of application of SMASE skills had no significant relationship with pupils' achievement in Mathematics and also Science. The possible explanation

for this finding is that the four years, in which SMASE programme has been under implementation in primary schools in Kenya, was not sufficient for teachers to learn, adopt and apply the SMASE skills in the classroom in a manner that had any meaningful effects on pupils' achievement. According to Adelman and Walking-Eagle (1997), teachers need time to learn about a new practice, introduce and fully institutionalize the new strategies into the classroom. On the other hand, Credaro (2006) contends that implementation of proposed innovations is the most complex stage of the change process and in the school context, this may be more ardous than in other organizations. Reforms in schools are complicated by teachers' inclination to resist change (Zimmerman, 2006).

CONCLUSIONS

The study concluded that SMASE-trained teachers' gender had no significant relationship with pupils' achievement in Mathematics and Science in primary schools in Murang'a County. Therefore, it was unlikely that SMASE-trained teachers of either gender had adopted the ASEI-PDSI approach in a manner that would have had any major effects on pupils' achievement within this relatively short period of time; especially when teachers are susceptible to resist change. Further, it was concluded that SMASE-trained teachers' experience had no statistically significant relationship with pupils' achievement in Mathematics and Science. Consequently, SMASE-trained teachers' past teaching experience may not bring about meaningful effects on pupils' achievement. Also teachers' level of application of SMASE skills had no statistically significant relationship with pupils' achievement in Mathematics and Science. This means that the four years in which SMASE programme had been under implementation in primary schools in Kenya was not sufficient for teachers to learn, adopt and apply the SMASE skills in the classroom in a manner that would have had any meaningful effects on pupils' achievement. Further, teachers are likely to resist change in schools.

RECOMMENDATIONS

This study recommends that primary schools should be accorded expert assistance during the transition period between the pre-SMASE and the post-SMASE period. This assistance would re-align teachers' application of SMASE skills in the teaching and learning process. On the other hand, majority of primary school teachers in the Kenyan context have undergone pre-service teacher training programmes. It is therefore recommended that for SMASE programme to be effective and sustainable, Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) and the Ministry of Education should integrate SMASE into the mainstream pre-service teacher training institutions. This undertaking is highly viable because primary school teacher training colleges are already actively involved in the implementation of SMASE as Regional INSET centres. This integration would reduce the burden of public and private expenditure incurred in the retraining of teachers who have already undergone a supposedly comprehensive pre-service teacher training programme. The learner centred ASEI-PDSI pedagogical principles advocated by the SMASE in-service programme should be an integral part of the regular pre-service teacher training programmes.

It is also recommended that possibilities of mounting pupil-related approaches should be explored.

This recommendation is based on the fact that earlier approaches such as SPRED, SbTD and SMASE had targeted teachers and headteachers of primary schools thereby ignoring pupils who are the ultimate target of any endeavour to improve performance. Notably, despite implementation of all these interventions, pupils' performance in Mathematics and Science in primary schools has remained far below educational stakeholders' expectations hence the need for change of the approaches to be used in future.

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