The Effects of Differentiated Instruction on Students Achievement in Mathematics by Gender in Secondary Schools in Meru County in Kenya

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Abstract

Mathematics is the base for all technologies in the world. Achievement in mathematics has caused deep concern in many countries over the years. In Kenya, mathematics is compulsory at primary and secondary school level. Boys and girls have different learning and behavior management needs hence the need to differentiate for those needs through use of instructional methodologies tailored to meet the gender needs. The purpose of the study was to investigate the effectiveness of differentiated instruction on students' achievement in mathematics by gender in secondary schools in Meru County in Kenya. The study sought to determine whether there was a difference in achievement by gender when students were instructed using differentiated instruction approach. The study employed the Quasi-experimental design and in particular Solomon Four-Group design. Simple random sampling technique was used to select the participating schools. The research instrument used was the Mathematics Achievement Test. Descriptive statistics and inferential statistics were used for data analysis. From the study there was evidence that when students were taught using differentiated instruction, gender did not affect their achievement in mathematics. The findings of this study may contribute to the knowledge base for differentiated instruction and a foundation for future studies.

Keywords: Differentiated Instruction, Gender and Achievement

1. Introduction

Mathematics plays a significant practical role in the lives of individuals and the world of society as a whole. It enhances problem solving and analysis skills in that it enhances students' logical, functional and aesthetic skills. Mathematics is applied in daily life in that it compels the human brain to formulate problems, theories and their solutions. Mathematics also prepares children to face a variety of simple to multifaceted challenges every human being encounters on daily basis. There is a general agreement in any society that every child should study mathematics at school to acquire skills for adult life (Orton & Wain, 1996). The achievement in mathematics needs to be improved by ensuring that all citizens have strong mathematics and science skills in order to keep a nation globally competitive. To remain competitive with-top-scoring countries, a nation needs to improve the mathematics, science and problem-solving skills of all students. These skills lay the foundation for innovation, increased productivity, development and implementation of new technologies. The starting point is to look at the curricula and instructional approaches and improve on them (Braswell, Daane & Grigg, 2003). Researches suggest that there are several possible

explanations for gender differences in learning and thus there is need to incorporate classroom activities that accommodate the different ways boys and girls learn.

Mathematics is used at the university as a filter of students into science and related careers (Eshiwani, 1984). Thus mathematics is used as a basic entry requirement into any of the prestigious careers such as Medicine, Architecture and Engineering among other degree courses. Despite this important role that mathematics plays in society, there has always been poor performance in the subject by both genders in national examinations in Kenya. There is need to focus on teaching boys and girls in different ways they need in that the teachers should tailor the instruction methodologies to the needs of the student.

All students deserve to become mathematically literate regardless of gender, socio-economic background, language, cultural background, learning ability or previous mathematics experiences (Burton, 2004). Equity in education has become a common concern with a focus on positive attempts to achieve equity in different educational systems (Moreno & Francia, 2004). Boaler (2002) found out that particular teaching approaches have different effects on performance of girls and boys. Equity in education can be achieved by teaching students corresponding to their level of readiness, their interests and their learning style, maximizing their opportunities for personal learning and growth (McLaughlin & Talbert, 1993). Thus equity in education and social justice can only be met if teachers find the way to correspond to the diversity of their students through differentiated instruction.

According to Tomlinson (2003), differentiated instruction is modified instruction that helps students with diverse academic needs and learning styles master the same challenging academic content. While it is accepted that the common basis for all student is a need for acceptance, nurturing and respect, attending to differences, assist each student in experiencing a degree of triumph by encouraging them to be all that they can be as individuals. The use of the one-size-fits-all curriculum no longer meets the needs of the majority of learners (McBride, 2004). In addition, addressing student differences and interest appears to enhance their motivation to learn while encouraging them to be committed and stay positive (Tomlinson, 2004). Tomlinson (1999) indicates that teachers in differentiated classroom accept, embrace and plan for the fact that learners bring many commodities to school but that learners also bring the essential differences that make them individuals. The above stated aspects of differentiated instruction make it an ideal way to reach the different needs of boys and girls in mathematics classroom.

The research by Chadwell (2010) indicates that boys and girls see, hear and engage in the learning process very differently. The learners also process information, respond to questions and make choices in different ways. Gender differences are further reason for teachers to embrace differentiated instruction within schools. All students despite the gender benefit from the availability of a variety of methods and supports and an appropriate balance of challenge and success. Given an equitable learning environment girls are capable of developing talent, skills and interest and can be mathematical equals of boys. Based on this idea there was need to investigate the effect of differentiated instruction on students' achievement in mathematics by gender.

2. Statement of the problem

Conventional instructional approach is not sufficient to support learning in classrooms which have students with different gender and needs. A large number of students are led to poor achievement,

whereas another big number is incapable to function to maximum benefit. This has been attributed to many factors such as lack of curriculum coherence, students' negative attitude towards mathematics, inadequate facilities, gender differences to inappropriate pedagogical practices. There was need for research on instructive approach and gender issue hence this study investigated effectiveness of differentiated instruction on students' achievement in mathematics by gender in secondary schools in Meru County in Kenya.

3. Objective

The objective was to determine whether there is a difference in achievement by gender between students that are exposed to differentiated instruction and those exposed to conventional instructional approach.

4. Hypothesis

There is no statistically significant difference in achievement by gender between form three students who are exposed to differentiated instruction and those exposed to conventional instructional approach.

5. Methodology

The study involved Quasi-experimental design that allows researchers to randomly select sample from the population and they do not require the random assignment of individual cases to the comparison groups. It also allows researchers to carry out studies in natural, real-life settings using probability samples. It involves the study of more than one sample often over an extended period of time. The study used a quasi-experimental design as the students are already constituted by the school administration and the researcher worked with existing streams as suggested by Nachmias & Nachmias (2004).

The researcher used in particular Solomon Four-Group design, which is appropriate for experimental and quasi-experimental studies. Solomon Four-Group is the most rigorous designs that can be used in quantitative studies for it involves two control groups as compared to other experimental designs. Solomon Four-Group enables a researcher to make a more complex assessment of the cause of changes in the dependent variable and even tell whether changes in the dependent variable are due to some interaction effect between the pretest and the treatment. The design permits four meaningful comparisons on a particular dependent variable (Shuttleworth, 2009).

Simple random sampling was used to assign four schools into experimental and control groups. This was done to reduce the possibility of bias entering the selection of sample schools. There were two experimental groups (E1 & E2) and two control groups (C1&C2). The experimental and control groups were from different schools to avoid interaction of subjects. Group E1 received pretest (O1), treatment (X) and posttest (O2). Group C1 received pretest (O3), no treatment and posttest (O4). Group E2 received no pretest but received treatment (X) and posttest (O5). Group C2 received only posttest (O6). The posttest O5 and O6 rule out any interaction between testing and treatment. Within the treatment condition, there was a group that is pretested (E1) and the one that is not (E2). The various combinations of tested and untested groups with treatment and control groups allow the researcher to ensure that confounding variables and extraneous factors have not influenced the results (Spector, 1981).

The instrument used was Mathematics Achievement Test (MAT). The MAT comprise of questions covering knowledge, comprehension, application and analysis in mathematics. MAT had 11 items with a total score of 50. The MAT was the pretest and posttest. The pretest and posttest was treated as a normal test that is administered to students. The topic of mathematics that was used in the study was probability. The pretest was administered first to E1 and C1 and then the treatment (teaching using differentiated instruction) was administered to the two experimental groups and after the students were taught the topic all the four groups did the posttest.

6. Results and Discussion

After the test were administered and marked, the scores of the MAT were analysed to make an inference whether a difference in instruction played a role in students' achievement by gender.

a) Mean Scores for Posttest

Information on Table 1 shows the mean scores of posttest obtained by students in MAT by gender in experiment and control groups.

Table 1
Posttest Mean Scores Obtained by Students in MAT by Gender

Group	Gender	N	Mean	S. D
Experiment Group	Boys	92	66.70	18.18
	Girls	94	69.62	15.45
Control Group	Boys	91	34.53	20.50
	Girls	97	33.22	19.10

Key: **N**- Total number of students; **S.D**- standard deviation

Results on Table 1 show that the mean score for boys in the experiment group is 66.70 and that of boys in control group is 34.53. The mean score for girls in experiment group was 69.62 and that of girls in control group was 33.22. The mean score for the experiment groups that was exposed to differentiated instruction was almost twice that of control group that was exposed to conventional methods in both cases for boys and girls. This implies that there was a difference in achievement when boys and girls were exposed to differentiated instruction in that there was improvement. Differentiated instruction therefore promotes equity and quality for all students. The results are consistent with Tomlinson (2001) who found out that differentiated instruction raises the bar for all learners.

The mean score for boys in the experiment group was 66.70 and for girls in the experiment group was 69.62. The two means slightly vary which implies that girls typically fared as well as boys. The boys and girls in experiment groups had almost same type of achievement scores. The differentiated instruction favoured both boys and girls since it improved their achievement. This means there was no gender gap when differentiated instruction was used. So it can be observed that differentiated instruction is an ideal way to reach the different needs of boys and girls in classroom that's why their performance did not differ much.

b) t-Test for Posttest Scores in Experiment Groups

To compare the means for boys and girls in the posttest scores in experiment groups, a t-test was done for the two groups and the results are shown on Table 2.

Table 2
The t-test of the Posttest MAT scores of Students by Gender Exposed to Differentiated Instruction

Gender	N	Mean	S.D	t-value	t-critical
Boys	92	66.70	18.18		
Girls	94	69.62	15.45	0.2387	1.96

The results on Table 2 shows that the t- computed is less than t- critical ($t_{computed} = 0.2387$ and $t_{critical} = 1.96$, $p<0.05$). The t-test results analysis reveals that the measures are not statistically different at 0.05 α-level implying the difference in achievement of boys and girls in the experiment group that was exposed to differentiated instruction was not significant. This indicates that the boys in experiment group were just as much involved in the learning process as girls in the experiment group. The findings of this study were consistent with Koutselini (2006) research who asserted that differentiation is effective for all students.

c) Mean Gain in Pretest and Posttest Scores in MAT

Data on Table 3 shows the mean gain obtained by students in pretest and posttest in MAT by gender.

Table 3
Mean Gain of Students in Pretest and Posttest Scores in MAT by Gender

Group	**E1**		**C1**	
Gender	Boys	Girls	Boys	Girls
N	34	47	42	50
Posttest Mean Score	74.53	65.62	44.33	45.12
Pretest Mean Score	17.29	19.28	15.14	12.24
Mean Gain	57.24	46.34	29.19	32.88

Key: **E1** – Experiment group with pre and posttest; **C1** – Control group with pre and posttest.

The results on Table 3 show that the mean gain for boys in experiment group (E1) was 57.24 and that for boys in control group (C1) was 29.19. The mean gain for boys in experiment group that were exposed to differentiated instruction was higher than that of boys in control group that was instructed using conventional instructional approach. The mean gain for girls in experiment group

(E1) was 46.34 and that for girls in control group (C1) was 32.88. The mean gain for girls in experiment group was higher than that of control group. The result on Table 3 of the mean gain illustrates the improvement of the experiment group students' achievement scores over those of control groups despite the gender. This implies that using differentiated instruction improves students' achievement in mathematics despite the gender. These findings concur with Lawrence-Brown (2004) whose research revealed that differentiated instruction develops an atmosphere for success for all learners for it allows for the creation of an environment in which all students can succeed and derive benefit.

d) Hypothesis Testing

The hypothesis stated that there is no statistically significant difference in achievement by gender between form three students when exposed to differentiated instruction and those exposed to conventional instructional approach. A one-way ANOVA procedure was used to determine whether there was statistical difference in mean scores among the boys and girls in experiment and control groups. The results are shown on Table 4.

Table 4

One-way ANOVA of the Posttest MAT Scores of Students by Gender Exposed to Differentiated Instruction and those Exposed to Conventional Instructional Approach

	Sum of Squares	Degree of freedom	Mean Square	F
Between groups	152030.900	3	50676.967	183.216
Within groups	102340.929	370	276.597	
Total	254371.829	373		

The results on Table 4 show that the total sum of squares is partitioned into between sum of squares and within sum of squares, representing the variation due to treatment and variation due to individual differences in the score. Mean square between groups is the variance due to the interaction between samples while mean square within groups is the variance due to the differences within individual samples. $F_{critical}$ (3,370) = 2.60 and $F_{computed}$ (3,370) =183.216, $p<0.05$ and so calculated F is significant. Results on Table 4 indicates that between groups estimate is more than 180 times the within group estimate. This test statistic gives strong evidence against HO: $\mu_1 = \mu_2 = \mu_3 = \mu_4$. The means differed significantly and so a difference exists among the mean values for the four groups. Thus HO: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4$. The results on Table 4 show that the F- computed is greater than F- critical and so the difference between the results is significant at the 5% level and the null hypothesis was rejected. The F-test results analysis reveals that the measures are statistically different at 0.05 α-level and so there was significant difference in achievement by gender between form three students when exposed to differentiated instruction and those exposed to conventional instructional approach. There was evidence of improved achievement when the students were exposed to differentiated instruction despite the gender. The findings are consistent with Eaton (2005) who concluded that differentiated instruction benefits all students because the teacher and the students are involved in the lessons.

e) Multiple Comparison Tests

To investigate the cause of rejection of the null hypothesis post-hoc test of multiple comparison tests using Scheffe test was used. Scheffe post hoc tests all pairs for differences between means and all possible combinations of means. It provides specific information on which means are significantly different from each other. Complex comparisons of means that involve contrasts of more than two means at a time were done. Information on Table 5 shows the results of the Scheffe's post hoc comparisons.

Table 5
Scheffe Post hoc Comparison of Post-test MAT Means for the Study Groups

(I) Group	(J) Group	Mean difference (I-J)	Standard Error	Sig.
C1	C2	10.00*	2.250	.000
	E1	-35.50*	2.350	.000
	E2	-33.87*	2.202	.000
C2	C1	-10.00*	2.250	.000
	E1	-45.49*	2.327	.000
	E2	-43.86*	2.178	.000
E1	C1	35.50*	2.350	.000
	C2	45.49*	2.327	.000
	E2	1.63	2.281	.916
E2	C1	33.87*	2.202	.000
	C2	43.86*	2.178	.000
	E1	-1.63	2.281	.916

KEY: **C1** - control group of girls; **C2**-control group of boys; **E1**-experiment group of boys; **E2**-experiment group of girls.

Results on Table 5 shows the obtained means on the rows and columns and subtracted differences between each pair of means in the interior cells producing a table of absolute mean differences to use in the evaluating the post hoc tests. The mean difference column gives the differences in the means of the two groups. An asterisk by the value indicates whether the difference is statistically significant given the method of multiple comparisons being used. The standard error column gives the difference between the two means of groups I and J. The significance column gives the significance of the difference under the multiple comparison method being used. Apart from only two, all the significant levels the rest are less than 0.05 so there is a difference in the means of the groups. Based on observed means the mean difference is significant at the 0.05 level.

The results on Table 5 shows that the mean differences of E1 versus E2 and E2 versus E1 are not significant at 0.05 level which confirms that difference in achievement of boys and girls in the experiment group that was exposed to differentiation was not significant. From Table 5 the significant level of E1 versus E2 and E2 versus E1 is 0.916 which is more than 0.05 so there is no difference in the means of the experiment group that was exposed to differentiated instruction. This suggests that the intervention of differentiation had significant effect on students' achievement.

Differentiated instruction creates successful learning for students and boosts their achievement. The results agree with the findings of Koutselini (2006) who found out that differentiated instruction is efficient and effective for all students.

7. Conclusions

The results from the study show that when boys and girls are exposed to differentiated instruction there is improvement in achievement in their scores. This means gender does not affect students' achievement in mathematics when students are taught using differentiated instruction. Differentiation favours all students and so it should be implemented to promote achievement for all students despite the gender. Thus differentiated instruction is a suitable approach for teaching both male and female students for there was provision of a learning environment that benefits both genders equally. The practice of differentiated instruction allows all students equal access to the curriculum while maintaining high expectation for students. From the study differentiated instruction is an approach applicable to the diverse students and so it should be used for all students.

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