The Effects of Computer-Aided Instruction in Mathematics on the Performance of Grade 4 Pupils

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Abstract

This study was undertaken to determine the effects of computer-aided instruction on mathematics performance of pupils at the Grade 4 level in Region 5. This focus was due to the trend of poor performances in mathematics at the National Grade 4 assessments for the past 5 years. Four intact Grade 4 classes in two primary schools were used in this study. Two classes were used as experimental group and the other two as control group. The Quasi Experimental, Nonequivalent Control Group design was employed for this study. The instrument which was used for data collection was a teacher-made test. The reliability coefficient of the instrument was .553, significant at alpha .01. The findings of the study indicated that there was a significant difference between the academic performance of pupils in mathematics who were taught using computer-aided instruction and those who were taught using the traditional method of teaching. Second, there was a significant difference between the academic performance of male and female pupils who were taught using computer-aided instruction and those who were taught using the traditional method of teaching. In addition, there was a significant difference between the academic performance of lower- and middle-income pupils who were taught using computer-aided instruction and those who were taught using the traditional method. Based on the findings of this study, some recommendations were made and among such were that computer-aided instruction should be integrated into the teaching of mathematics at the Grade 4 level in the area of study.

Introduction

Statement of the Problem

Kiamanesh (2006) posited that mathematics is not just an important subject in the school's curriculum but an important body of knowledge and skills applicable to daily life. He also indicated that mathematics is important and of significant value to all irrespective of gender, socioeconomic status, and background. Hence, it is disturbing to note that pupils are performing poorly in mathematics on the West Coast of Berbice. The problem studied was the poor performance of Grade 4 learners in mathematics at the National Grade 4 Assessment.

This study therefore ascertained the effects of computer-aided instruction in mathematics on the performance of Grade 4 pupils in the subject. Gender and socioeconomic status were used as controlling variables because they might have effects on pupils' academic performance. Thus, this study also determined whether computer-aided instruction in mathematics had any effect on the academic performance of

pupils irrespective of gender and socioeconomic status (Tables 1-5).

Purpose of the Study

This study was designed to ascertain whether

1. There was any significant difference between the academic performance of pupils in mathematics who were taught using computer-aided instruction and those who were taught using the traditional method.
2. There was any significant difference between the academic performance of male and female pupils who were taught using computer-aided instruction

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Table 1. Summary of National Academic Performance of Pupils at National Grade 4 Assessment in Mathematics, 2010-2014.

	Mathematics performance percentage pass		
Year	Boys (%)	Girls (%)	Total (%)
2010	12	16.5	18.5
2011	14.8	20.5	24.5
2012	12.5	20.5	22.5
2013	16.4	26.5	26.5
2014	18.5	29.7	34.7

Source. NCERD National Grade 4 Analysis for Mathematics performance nationally, 2010-2014.
Note. NCERD = National Center for Educational Resource Development.

Table 2. Summary of Regional National Academic Performance of Pupils at National Grade 4 Assessment in Mathematics, 2010-2014—Region 5.

	Mathematics performance percentage pass		
Year	Boys (%)	Girls (%)	Total (%)
2010	10.0	20.5	17.5
2011	12.0	28.5	22.5
2012	18.5	20.5	20.0
2013	14.4	26.5	23.0
2014	21.5	25.9	23.4

Source. NCERD National Grade 4 Analysis for Mathematics performance regionally for Region 5, 2010-2014.
Note. NCERD = National Center for Educational Resource Development.

Table 3. Summary of School X Academic Performance of Pupils at National Grade 4 Assessment in Mathematics, 2010-2014.

	Mathematics performance percentage pass		
Year	Boys (%)	Girls (%)	Total (%)
2010	15.1	19.6	17.8
2011	19.7	23.0	21.4
2012	17.8	19.2	16.4
2013	24.4	26.8	25.5
2014	25.3	28.7	27.0

Source. NCERD National Grade 4 Analysis for Mathematics performance by individual school, 2010-2014.
Note. NCERD = National Center for Educational Resource Development.

Table 4. Summary of School Y Academic Performance of Pupils at National Grade 4 Assessment in Mathematics, 2010-2014.

	Mathematics performance percentage pass		
Year	Boys (%)	Girls (%)	Total (%)
2010	11.2	17.6	19.8
2011	17.5	22.0	20.3
2012	12.2	19.6	15.4
2013	19.4	25.5	23.5
2014	23.8	27.7	25.7

Source. NCERD National Grade 4 Analysis for Mathematics performance by individual school, 2010-2014.
Note. NCERD = National Center for Educational Resource Development.

Table 5. National Summary of Guyana's Mathematics Performance by Mean and Standard Deviation, 2014.

	Mean performance for mathematics		
2014	Boys	Girls	Total
Paper 1 (30)	13	15	14
Paper 2 (20)	5	6	6
Total (50)	18	21	20
Deviation			
Paper 1	6.3	5.6	11.4
Paper 2	5.9	5.6	10.9
Total	6.2	5.7	11.3

Source. NCERD National Grade 4 Analysis for Mathematics performance nationally, 2010-2014.
Note. NCERD = National Center for Educational Resource Development.

and those who were taught using the traditional method.

3. There was any significant difference between the academic performance of pupils of lower and middle socioeconomic status who were taught using computer-aided instruction and those who were taught using the traditional method.

Review of Related Literature

The theoretical framework of this study is based on Piaget and Bruner's work on Constructivism, as well as Resnick's (1987) work on "The Thinking Curriculum." From observation, mathematics is considered one of the core subjects of curriculum universally. Hence, globally, mathematics is compulsory from kindergarten to college (Ding, Song, & Richardson, 2007). Brothen and Wambach (2000) stated that the complex nature of mathematics supports a constructivist theory of learning, which makes it suitable for computer-aided instruction. Fundamental to the understanding of constructivism is that pupils in mathematics classes should be active knowledge seekers and constructors. This pursuit of knowledge is fueled by natural innate curiosity. Zhao, Valcke, Desoete, & Verhaeghe (2011) posited that an examination of

Piaget's theory of learning is essential to the understanding of constructivism. His central idea is that knowledge proceeds neither solely from experience of objects or phenomenon nor from an innate programming performed in the subject but from successive constructions. From observation, in mathematics classes where traditional instructional strategies have been the dominant method of instruction, the pupils might not internalize the vast amount of knowledge or

content that is presented by the teacher. Piaget (1985, cited by Zhao, et al. 2011) noted that it is almost impossible to develop full understanding in that manner. He indicated that pupils construct through active interaction with the classroom environment. Piaget's work on cognitive development in 1960 noted that children from 7 to 12 years are in the concrete operational stage. He explained that children at this stage cannot think abstractly and internalize a vast amount of knowledge the way traditional instruction presents knowledge. The use of computer-aided instruction to teach 8-year-old pupils' mathematics may provide pupils the concrete materials in simulated forms. It is postulated that this provides learners with the opportunity for active participation and interaction in the class. Zhao posited that this would enable them to have the concrete relationship with materials needed as they actively participate in learning mathematics.

Similar to Piaget, Bruner (1986) as cited by Zhao, et al. (2011), learning is an active process in which learners construct new ideas or concepts based on their experiences and past knowledge. Like Piaget, Bruner advocated for pupil-centered learning where the learner selects and transforms information, constructs hypotheses, and makes decisions. It is important to note that these decisions rely on cognitive structures such as schema and mental models. The interconnection of the new experience with prior knowledge results in the reorganization of the cognitive structure, which creates meaning and allows the pupil to go beyond the information that was given by the teacher. For that reason, instructions must be designed to facilitate the extrapolation of content where the pupil will be able to internalize and make sense of materials presented. Hence, constructivism disputes traditional theories of learning which claim that learning is transmitted knowledge and that teaching should be teacher-centered, systematic, and structured.

Piaget (1969) forwarded that an 8-year-old child would be in the developmental stage of concrete operations. Lowrey (1986) and Seger and Cincotta (2002) argued that at approximately the age of 7 or 8 years, the child makes a transition from the preoperational stage to the stage of concrete operations. The preoperational stage is defined as egocentric and subjective. During the preoperational stage, we see the beginnings of symbolic functioning occurring. Lowrey posited that a child thinks in terms of classes, can handle number concepts, and is able to concentrate only on one dimension of a situation (Seger and Cincotta, 2002). At the start of middle childhood, these developmental characteristics change and mature into a less egocentric thought process, a more conceptual organization (Seger and Cincotta, 2002). The 8-year old thinks concretely, applying mental notions to real objects and events but is unable to think in abstract or hypothetical terms. From observations, many mathematics lessons from as early as Grade 2 are taught in abstraction. This only confuses the learners. Computer-aided instruction in mathematics lessons brings the natural setting and symbolic learning relative to that age. Computer-aided instruction will promote the development of the cognitive skills of the child at this stage. The researcher therefore proposed that at this level of cognitive development, the learners are facing many challenges. To address some of the challenges, it may be wise to use computer-aided instruction in mathematics lessons.

Heis (2008) posited that the study of mathematics should develop critical reasoning, inference, and analytical skills in learners. When learners are failing at basic mathematical concepts at the foundation classes in elementary (primary) school, it may indicate a major problem not with the learners. Resnick (2010) and Shulman (1987) indicated that a Thinking Curriculum can remedy the poor development of critical reasoning, inference, and analytical skills in learners. The term *Thinking Curriculum* entered education in the 1980s through the work of Resnick. In 1987, she noted that the curriculum in use in this period of elementary mathematics is not meeting the needs of the learners. While traditional teaching tends to teach content and process separately, a Thinking Curriculum as proposed by Resnick, with utilization of computer-aided instruction, weds process and content, a union that typifies real-world situations; that is, pupils are taught content through processes encountered in the real world. Some thinking and learning processes apply across all content areas and all areas of life, and thus are generic: for example, decision making, problem solving, evaluating, and comparing. These learning processes are related to life (Shulman, 2013). Important to the teaching of mathematics is Pedagogical Content Knowledge and Content Knowledge (Shulman, 1987). This is vital to Resnick's proposition for the Thinking Curriculum in mathematics.

In Guyana, a small fraction of the learners achieves the elite proficiency level, and most of them come from the labeled elite state primary school and private school (National Center for Educational Resource Development [NCERD], 2014). Resnick's conception and implementation/trials of the "Thinking Curriculum" may be achievable in any school system in which there are expert hands and ideal circumstances supported by computer-aided instruction. The Thinking Curriculum calls for instruction that is high in cognitive demand that is embedded in specific, challenging subject matter which is more suitable for computer-aided instruction than traditional methods of teaching. Computer-aided instruction provides the concrete materials support needed in and innovative modern way to support deeper reasoning, explaining, and problem solving. Piaget and Bruner advocated for child-centered learning as did Resnick and Shulman. Kellner (2010) and Resnick (2010) argued that the purpose of education is to develop self-actualizing persons. From observation, this is relevant for the teaching of mathematics where pupils should be active knowledge seekers which might be critical to developing analytical thinking and innate curiosity.

Seger and Cincotta (2002) posited that education is an active lifelong process. The constructivists posited that knowledge is not transmitted from teacher to pupil but

actively constructed by each student or group of pupils. Pupils are active agents who engage in their own knowledge construction by integrating new information into their schema or mental structure. Computer-aided instruction encourages active interaction among students as they constantly exchange and test ideas and experiences with each other. Pupils are excited by computers in their classrooms. Thus, it is theoretically sound to state that teaching and learning via computer-aided instruction is aligned with Constructivist Pedagogy and the Thinking Curriculum. Hence, computer-aided instruction might have the potential to improve the academic performance of Grade 4 pupils in mathematics.

Method

Research Design

The design for this study was Quasi Experimental, Nonequivalent Control Group Design. The Quasi Experimental design was used because unlike the true experimental design, it does not require randomization of sample. Randomization of sample for an experimental study is not practicable in a school system. Therefore, the Quasi Experimental design was most appropriate for this study. Gay (2000) posited that this design can meet all the requirements of the true experimental design except randomization.

Gay (2000) stated that with this design, a cause and effect relationship can be hypothesized, which stipulates that Condition X will give rise to Condition Y. The researcher used four intact classes in two schools: one school as the control group and the other as the experimental group. The experimental school (group) and the control school (group) were determined through balloting. Both groups were pretested simultaneously, before the administering of the treatment. At the end of the treatment, a posttest was administered simultaneously to both groups (Table 6).

Threats to Internal Validity

This study controlled for certain extraneous variables that could have affected the results of the study. They were as follows:

1. History

Schneider, Carnoy, Kilpatrick, Schmidt, and Shavelson (2007) posited that the use of the control group in this study controlled for history because both the control and experimental groups were exposed to the same teaching learning conditions prior to this study. Besides, pupils in the four groups were of the same general characteristics and developmental level. Therefore, the presence of the control group removed doubts of biases as both groups could be exposed to the same events outside the prescribed experimental treatment (Gay, 2000).

Table 6. Nonequivalent Control Group Design.

Groups	Pretest	Treatment	Posttest
Experimental group	O_1	X_1	O_2
Control group	O_3	X_2	O_4

Note. O_1 = pretest results of experimental group; O_2 = posttest results of experimental group; O_3 = pretest results of control group; O_4 = posttest results of control group; X_1 = computer-aided instruction (experimental treatment); X_2 = traditional method of teaching (control group).

2. Maturation

Shadish, Cook, and Campbell (2002) stated that the length of the study can cause maturation effects on the population. The study was conducted for 6 weeks. This short duration controlled for maturation. The pupils in both the control and experimental groups were of similar ages.

3. Instrumentation

Gay (2000) posited that instrumentation threats occur when two different instruments are used for pretesting and post-testing, especially if the tests are not of equal difficulty. The same test items were used for the pretest and posttest that were administered to both groups. Consequently, this controlled for instrumentation threat (Shadish et al., 2002).

4. Testing

Both control and experimental groups were exposed to the same pretest. This removed doubts of preferences or biases toward the participants of any of the two groups. Administering the same pretest to the control group and the experimental group controlled for testing in case there was sensitization as a result of the exposure to the pretest before the posttest (Schneider et al., 2007).

5. Hawthorne Effect

The participants in both groups were taught mathematics by their class teachers. The class teachers are qualified to teach using computer-aided instructions and/or blended instructions. This was proven because both schools had their teachers participated in a training sessions by the NCERD. Participants were not told that they were participating in a study. This controlled for the Hawthorne Effect (Schneider et al., 2007; Shadish et al., 2002).

6. Treatment Diffusion

Treatment Diffusion could have been a possible threat to the outcome of this study. Because of this, the researcher did not allow the pupils of the control group nor experimental group to be aware of the two different treatments being administered.

This was ensured because neither of the groups were made aware that they were participating in a study. Shadish et al. (2002) and Schneider et al. (2007) stated that this will eliminate the possibility of overlapping and participants having knowledge of each other's treatment. Schneider et al. noted that having knowledge of each other's treatment often leads to groups borrowing aspects from each other so that the study no longer has two distinctly different treatments.

Awareness of the difference in treatment could have led to unnecessary competition among the experimental and control groups or among the two schools involved in the study. In addition, eliminating any form of disgruntle attitudes as to why they were not part of the group being taught via computer-aided instructions.

7. Differential selection of participants

Gay (2000) posited that initial group differences of intact classes as those proposed to be used in this study can account for posttest differences. The study at its initial stage determined the equivalence between the two groups. The groups were found to be equivalent in academic performance, gender distribution, socioeconomic status, and ethnic composition. This was done before the administration of the treatments and posttest.

Population

The population for this study was the current Grade 4 pupils of the 10 primary schools on the West Coast of Berbice. This education/school district is considered to be failing at national assessments. This was in fifth administrative region of Guyana. Guyana is the only English-speaking South American country. This research targeted pupils of the mainstream Grade 4 classes. Pupils of that grade ranged in age from 8.4 to 9.3 years.

The approximately 625 pupils were multicultural consisting of Amerindian, Indians, Africans, and mixed race, who lived predominantly in small villages on the West Coast of Berbice. The lot consisted of approximately 290 boys and 335 girls.

Most of the pupils came from public servant families, farmers, and fishermen; a commercial family and a minor fraction of them were unemployed.

Sample

The sample for this study was the current Grade 4 pupils of two similar primary schools on the West Coast of Berbice. This was in Region 5. The two schools were identified through random sampling. There were four intact Grade 4 classes in the two primary schools. The ballot method was used to determine the experimental and control groups. School X was the control group. It was made up of 52 pupils. There were 27 males and 25 females. School Y was the experimental group. It was made up of 53 pupils. There were

25 males and 28 females. This sample represented approximately 17% of the population. The experimental and control groups were made up of two intact classes each.

Instrumentation

The research instrument that was used to collect data for this study was a teacher made test. Gay (2000) argued that the same instrument must be used as the pretest and post-test instrument. The teacher made test was used for both pretest and post-test. The teacher made test comprised of twenty (20) objective items. The objective items were multiple choice items on two topics: Percentages and Decimals. According to Phye (1997), this type of questions eliminate the possibility for subjectivity in scoring. The same test items were used for both pretest and post- test. (**see appendix # 2 for the instrument sample.**) .

Validation of Instrument

Four specialists in the field of education who are experts in mathematics and measurement and evaluation from two tertiary institutions were employed to examine the content validity of the test items. This was done to ensure that all the items were directly related to the content and no unrelated items were included in the test.

Reliability of Instruments

The instrument was piloted with Grade 5 pupils who were not part of the sample for the study. A pilot test using the test–retest approach was carried out to determine the reliability of the research instrument. A reliability coefficient of .553 was obtained using Pearson product–moment correlation coefficient to ensure the instrument provides reliable data for the study. The correlation is significant at the .01 level and falls within the acceptable range for the size of the sample and the length of the study (Table 7).

Procedure for Data Collection

To commence this study, the first step involved soliciting permission from the Regional Education Officer, Region 5, and the head teachers of the two schools that were used for the study. Four teachers of Grade 4 were asked to assist with the administration of the treatment.

After the preliminaries, the pretest was simultaneously administered to the experimental and control groups. After the pupils had completed the pretest, the scripts were immediately marked and data were aggregated by the researcher. The treatments were then administered for a 6-week period. The experimental and control groups were instructed using computer-aided instructions and traditional teaching methods, respectively. The experimental and control groups were exposed to the same content simultaneously throughout the study.

Table 7. Reliability Coefficient of Instrument Using the Pearson Product–Moment Correlation Coefficient.

Descriptive statistics

	M	SD	n
Pilot A	7.5600	4.89966	25
Pilot B	7.4800	5.35506	25

Correlations		Pilot A	Pilot B
Pilot A			
Pearson correlation		1	.553**
Significance (two-tailed)			.004
n		25	25
Pilot B			
Pearson correlation		.553**	1
Significance (two-tailed)		.004	
n		25	25

**Correlation is significant at the .01 level (two-tailed).

At the culmination of the treatment period, the posttest was administered to both groups simultaneously. The completed test scripts were marked immediately and analyzed.

Statistical Technique for Analysis of Data

Descriptive statistics and inferential statistics were used to analyze the data for this study. The descriptive statistics were mean and standard deviation, whereas the inferential statistics were t test and ANOVA.

The t test was used to analyze Research Question 1, because it involved the means of two groups. Shadish et al. (2002) and Schneider et al. (2007) noted that t test can be used to determine whether there is any significant difference between the means of two groups.

The simple, or one-way, ANOVA was used to analyze data for Research Questions 2 and 3. ANOVA was considered an appropriate analysis technique for these two research questions because they involved the means of multiple groups. Gay (2000), Shadish et al. (2002), and Schneider et al. (2007) posited that it is more effective and convenient to perform one-way ANOVA than to perform several t tests because it is much more efficient and keeps the error rate under control. The research questions were tested for significant difference at .05 level of significance.

Ethical Consideration

The British Educational Research Association (2011), under the *Ethical Guidelines for Educational Research, Second Revision*, stated that before the commencement of any study/primary research, the researcher needs to get the consent/permission from target sample of the population. In addition, if the researcher is conducting an experiment which is the

Table 8. Mean Scores for Control and Experimental Groups.

Paired samples statistics	M	n	SD	SE M
Pair 1				
Pretest control group	2.2308	52	2.79787	.38799
Pretest experimental group	3.4038	52	3.47687	.48215

Paired samples correlations	n	Correlation	Significance
Pair 1			
Pretest control group and pretest experimental group	52	−.042	.767

approach of this study, the participants must first agree to be a part of the study. The participants in this study were children, and the consent of their parents and the relevant education authorities were sought. If after a participant had consented and he or she wishes to withdraw his or her responses and opt out of the study, this will be facilitated and their pretest and posttest scores will be removed from the data analysis. The researcher followed all ethical principles guiding the conducting of an experiment. Conclusions arrived at during the analysis, and interpretation of the data objectively was shared with all participants.

Limitations

1. This study was limited to two primary schools in Region 5. As a result, the findings may not be representative of the performances of similar groups of Grade 4 primary school pupils in other nine administrative regions in Guyana.
2. The performance on the teacher-made test for this study may not reflect future performance on the Grade 4 Assessment.

Results and Discussion

For the equivalence of the experimental and control groups, see Tables 8 and 9.

Tables 10 and 11 show the test for significant difference between the academic performance of pupils in mathematics who were taught using computer-aided instruction and those who were taught using the traditional method.

Table 10 shows the posttest scores of pupils in both groups. Those who were exposed to computer-aided instruction (experimental group) had a posttest mean of 11.2308 with a mean gain of 7.827. Those who were taught by the traditional teaching method (control group) had a posttest mean of 4.5962. They had a mean gain of 2.3654 Thus, both groups showed improvements in their academic performance after treatments. However, the pupils in experimental group had a greater mean gain. This implies that the pupils in the experimental group performed better than those in the control group.

Table 9. The *t* Test to Determine the Significant Difference Between the Pretest Scores of the Experimental and Control Groups.

Paired samples test

				Paired differences				
				95% confidence interval of the difference				Significance
	M	*SD*	*SE M*	Lower	Upper	*t*	*df*	(two-tailed)
Pair 1								
Pretest control group– pretest experimental group	−1.17308	4.55348	.63145	−2.44077	.09462	−1.858	51	.069*

Note. As indicated in this table, there is no significant difference between the performance of students in the experimental group and those in the control group at the pretest level (*t* = −1.858, *p* = .069; *p* > .05).
*p > .05.

Table 10. Comparison of Pretest and Posttest Mean Scores of the Experimental and Control Groups.

	No. of pupils	Mean pretest	Mean posttest	Gain
Experimental	53	3.4038	11.2308	7.8270
Control	52	2.2308	4.5962	2.3654

The result of the study in Table 11 shows that there was a significant difference between the academic performance of experimental group who were exposed to computer-aided instruction and those who were taught using the traditional method of teaching (*t* = −6.677, *p* < .05). The better performance of the experimental group may be attributed to the computer-aided instruction the pupils were exposed to.

From the researcher's observations and that of the other teachers, the pupils in the computer-aided instruction class were active during the lesson. They were excited and showed interest in the lessons. They achieved the instructional objectives very fast and attained concepts without many repetitions of activities. In contrast, the pupils in the traditional instruction class while engaged were not as motivated or as active during the lessons. This might have affected their performance. The traditional method of teaching is teacher-centered and it is characterized by direct instruction. Direct instruction as earlier noted includes the presentation of material, thinking aloud by the teacher, guided practice, correction and feedback, and modeling by the teacher (Kinney & Robertson, 2003). The teacher plays the role of the expert imparting knowledge to students, and hence the students are passive learners. It is the teacher who decides what, when, and how students should learn.

In Table 12, the mean of the pretest scores and the mean of the posttest scores for male pupils in the experimental group were 4.3929 and 11.4643, respectively, with a gain of 7.071. The mean of the pretest scores and the mean of the posttest scores for the female pupils in the experimental group were 2.32 and 11.08, respectively, with a gain of 8.76. In the control group, the mean of the pretest scores and the mean of the posttest scores for male pupils were 2.5185 and 4.3571, respectively, with a gain of 1.8386; the mean of the pretest scores and the mean of the posttest scores for the females were 1.920 and 4.68, respectively, with a gain of 2.76. The result of this study showed that both the male and female pupils in the experimental and control groups improved in their performance after being exposed to treatment but those in the experimental group performed better than their counterparts in the control group.

Table 13 shows $F = 49.355$, $p = .000$; $p < .05$. As the *p* value is less than .05, there was a significant difference between the academic performance of female and male pupils in mathematics who were exposed to computer-aided instruction and those who were exposed to the traditional method.

A post hoc test revealed that in the experimental group, the male and female pupils performed significantly better than their counterparts in the control group. As both male and female pupils performed significantly better than their counterparts in the control group, the better performance might be attributed to computer-aided instruction that the pupils were exposed to.

In Table 14 for the experimental group, *F* value = .062, $p = .805$. As the *p* value is greater than .05, there was no significant difference between the academic performance of female and male pupils in mathematics in the experimental group at the posttest level.

A post hoc test revealed that there was no significant difference between the performance of male and female pupils in the experimental group. This implies that gender had no effect on the performance of pupils in the experimental group. Computer-aided instruction had similar effects on the performance of both male and female pupils.

The result of this study is in line with that of an international study conducted by the Institute for Educational Advancement (IEA) across all countries. The international

Table 11. The *t* Test for Significant Difference Between the Posttest Scores of the Experimental and Control Groups.

Paired samples test

| | | | | 95% confidence interval of the difference | | | | Significance |
	M	SD	SE M	Lower	Upper	t	df	(two-tailed)
Pair 1								
PostCG–PostEG	−6.63462	7.16481	.99358	−8.62931	−4.63992	−6.677	51	.000*

Note. CG = Control Group; EG = Experimental Group.
*p < .05.

Table 12. Pretest and Posttest Mean Scores of Male and Female Students in the Control and Experimental Groups.

	No. of males	No. of females	Mean: Males pretest	Mean: Males posttest	Gain	Mean: Females pretest	Mean: Females posttest	Gain
Experimental	28	25	4.3929	11.4643	7.0714	2.32	11.08	8.76
Control	27	25	2.5185	4.3571	1.8386	1.92	4.68	2.76

Table 13. ANOVA Test for the Significant Difference Between Male and Female Students in the Control and Experimental Groups.

| | | | ANOVA | | | |
	Sum of squares	df	Mean square	F	Significance	Decision
Between groups	1,173.640	1	1,173.640	49.355	.000	Significant difference
Within groups	2,449.274	103	23.779			
Total	3,622.914	104				

*p < .05.

Table 14. Analysis of Performance Between Genders.

	Sum of squares	df	Mean square	F	Significance
PostCG					
Between groups	1.377	1	1.377	.082	.776
Within groups	857.869	51	16.821		
Total	859.246	52			
PostEG					
Between groups	1.950	1	1.950	.062*	.805
Within groups	1,608.804	51	31.545		
Total	1,610.754	52			

Note. CG = Control Group; EG = Experimental Group.
*p > .05.

study revealed that there was essentially no difference in achievement between boys and girls at either the eighth or fourth grade (Mullis, Martin, Gonzalez, & Chrostowski, 2004). Kiamanesh (2006) indicated that while males are more technically inclined and would gravitate more toward computers, there is no advantage of use to a single gender. It

was further revealed that using computer-aided instruction, the performance of both genders was relatively similar. Brothen and Wambach (2000) posited that students collectively (males and females), in this technology era, relate better to computer-aided instruction than traditional method of instruction. From the results of their study, they concluded

that the use of computers does not benefit one gender more than the other.

Summary

The purpose of this study was to ascertain the effects of computer-aided instruction in mathematics on the performance of Grade 4 pupils. It was evident that pupils' performance in mathematics at the National Grade 4 Assessment was poor. Hence, this study was undertaken in an attempt to determine whether the use of computer-aided instruction in the teaching of mathematics would improve pupils' academic performance. Answers to three research questions were sought. The research questions were as follows:

Research Question 1: Is there any significant difference between the academic performance of pupils in mathematics who are taught using computer-aided instruction and those who were taught using the traditional method?
Research Question 2: Is there any significant difference between the academic performance of male and female pupils who are taught using computer-aided instruction and those who were taught using the traditional method?
Research Question 3: Is there any significant difference between the academic performance of pupils of lower and middle socioeconomic status who are taught using computer-aided instruction and those who were taught using the traditional method?

Literature reviewed for this study indicated that the use of computer-aided instruction in the teaching of mathematics improves pupils' academic performance. The research design was the Quasi Experimental, Nonequivalent Control Group design. Four intact classes of 105 Grade 4 pupils at two primary schools in Region 5 were used for the study. A teacher-made test was the instrument used to obtain the data for this study. The instrument had a reliability coefficient of .553. It was obtained using Pearson product–moment correlation coefficient. The data were analyzed using descriptive and inferential statistics. The descriptive statistics were mean and standard deviation, whereas the inferential statistics were t test and ANOVA. Findings of this study showed that there was a significant difference between the academic performance of pupils in mathematics who were taught using computer-aided instruction and those who were taught using the traditional method of teaching. Second, there was a significant difference between the academic performance of male and female pupils who were taught using computer-aided instruction and those who were taught using the traditional method of teaching. There was a significant difference between the academic performance of lower- and middle-income pupils who were taught using computer-aided instruction and those who were taught using the traditional method of teaching.

Conclusion

Based on the findings of this study, the following conclusions were drawn.

There was a significant difference between the academic performance of pupils in mathematics who were taught using computer-aided instruction and those who were taught using the traditional method of teaching. From this study, pupils in the experimental group performed much better than those in the control group at the posttest level. The better performance of the experimental group might be due to their exposure to computer-aided instruction.

There was a significant difference between the academic performance of male and female pupils who were taught using computer-aided instruction and those who were taught using the traditional method of teaching. As both male and female students in the experimental group performed better than their counterparts in the control group, the better performance may be attributed to computer-aided instruction. Although the improved performance of both male and female pupils in the experimental group was better than their counterparts in the control group, computer-aided instruction had similar effects on both genders in the experimental group. This means gender had no effect on the performance of the pupils in the experimental group.

There was a significant difference between the academic performance of lower- and middle-income pupils who were taught using computer-aided instruction and those who were taught using the traditional method of teaching. From this study, the lower- and middle-income pupils in the experimental group improved better in their performance than their counterparts in the control group. As both the lower and middle socioeconomic pupils in the experimental group performed better than their counterparts in the control group, the better performance might have been due to computer-aided instruction. Furthermore, as there was no significant difference between the performance of the two income groups of students in the experimental group, computer-aided instruction had similar effects on both groups. The socioeconomic status of the pupils seemed not to have had any influence on the better performance of the experimental group.

Implications

The results of the study had the following implications:

Grade 4 Teachers

1. Grade 4 teachers should become more resourceful and creative using the traditional method in teaching mathematics to the Grade 4 level pupils. Allow pupils to treat mathematics as they would treat parts of daily life that utilize aspects of mathematics. Hence, teachers should modify their teaching

approaches even if it is traditional methods. This will motivate pupils and arouse the interest of both genders for mathematics.

2. Grade 4 teachers need to be aware that students come to their classrooms with varying abilities and learning styles. Therefore, they should allow pupils to also bring modern technology into the classroom. They need to also adjust their views on why pupils are performing poorly in the subject because this research proved that computer-aided instruction can improve academic performance.

NCERD

1. There is need for the inclusion of professional development programs in the education system for teachers which would enable them to acquire relevant knowledge and skills for the successful teaching of mathematics using computer-aided instructions. Be innovative with what you have in the classroom. Shulman (2010) reemphasized that the effectiveness of the methodology used in teaching mathematics is the main contributor to success learning. Hence,

Resnick (2010) posited that teachers' methodology is a powerful predictor of learners' motivation and academic performance. Resnick (1987, 2010) stated that the activities and the way they are organized, sequenced, and presented in the classroom determine the outcomes. Outcomes in this context refer to learners' academic performance in mathematics.

2. Provide computer-aided instruction coaches and computers for teachers at the Grade 4 level to improve their competences in teaching mathematics.

3. The Ministry of Education in collaboration with the NCERD needs to pay necessary attention to teachers' training in mathematics. There should be more compulsory mathematics, technology use courses as a part of initial teacher training.

School Administrators

Collaborate with the community and other stakeholders to equip schools with computers that can be used as tools for instruction. Foster the development of an atmosphere for cooperative teaching with computer-aided instruction, thus enhancing pupils' learning and academic performance

Appendix 2: Pretest/Post test Instrument

Pretest/Post test
MATHEMATICS TEST

Time: 45mins   Examiner: Lidon Lashley
Name: _____   Grade 4 _____
Gender: Male   Female

This test contains TWENTY (20) items; you are required to complete all items. Draw a heavy dark line through the letter closest to the correct response

1. The symbol for percentage is _____
   (a) #   (b) :   (c) %   (d) $

2. ¾ expressed as a percent is _____
   (a) 25%   (b) 50%   (c) 75%   (d) 100%

3. 25% converted to a fraction in its lowest term is _____
   (a) ¼   (b) ½   (c) ¾   (d) 2/5

4. 60% of $120 is _____
   (a) $60   (b) $ 72   (c) $84   (d) $ 120

Study the problem below then answer questions 5 -8
Samuel has 40 marbles. 10 marbles are blue, 5 marbles are red, 5 marbles are black and the others are green.

5. What percent of the marbles are blue?
   (a) 10%   (b) 25%   (c) 50%   (d) 75%

6. What percent of the marbles are green?
   (a) 10%   (b) 25%   (c) 50%   (d) 75%

7. What percentage more of the marbles are green than blue?
   (a) 10%   (b) 25%   (c) 50%   (d) 75%

8. Which colours altogether represent 75% of the marbles?
   (a) red and blue   (b) blue and green   (c) green and red   (d) black and red

Study the problem below then answer questions 9 and 10
There are 20 pupils in a class. 60 % of them are girls.

9. How many girls are in the class?
   (a) 12   (b) 10   (c) 8   (d) 6

10. How many boys are in the class?
    (a) 4   (b) 8   (c) 12   (d) 16

11. The first number behind the decimal point is called a _____
    (a) tens   (b) tenths   (c) hundreds   (d) hundredths

12. 6234 written so that 6 has the value of 6 ones is _____
    (a) 6.234   (b) 62.34   (c) 623.4   (d) .6234

13. 0.7 written as a fraction is _____
    (a) 7/10   (b) 7/100   (c) 10/7   (d) 100/7

14. 3 ½ written as a decimal is _____
    (a) 3.2   (b) 31.5   (c) 3.5   (d) 3.1

15. 3.5 + 2.6 = _____
    (a) 5.11   (b) 6.1   (c) 6.11   (d) 16

16. 5 – 3.6 = _____
    (a) 2   (b) 2.4   (c) 1   (d) 1.4

17. 0.2 multiply by 10 equals _____
    (a) 0.02   (b) 0.2   (c) 2   (d) 20

18. 0.6 multiply by 3 equals _____
    (a) 0.18   (b) 0.9   (c) 0.63   (d) 1.8

19. 4.2 divided by 3 equals _____
    (a) 4.2   (b) 0.2   (c) 1.2   (d) 1.4

20. Arrange the following decimals from largest to smallest
    0.4, 0.2, 0.5, 0.9
    (a) 0.9, 0.5, 0.4, 0.2   (b) 0.5, 0.9, 0.4, 0.2
    (c) 0.2, 0.4, 0.5, 0.9   (d) 0.2, 0.5, 0.4, 0.9

END

ANSWER KEY

1. C
2. C
3. A
4. B
5. B
6. C
7. B
8. B
9. A
10. B
11. B
12. A
13. A
14. C
15. B
16. D
17. C
18. D
19. D
20. A

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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