



## **Full Length Research Article**

### **EFFECTIVENESS OF COMPUTER-BASED INSTRUCTION: AN ANALYSIS BY GENDER**

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#### **ABSTRACT**

This study was designed to explore the instructional potential of a Computer-Based Instruction (CBI) program in the teaching of probability concepts to form three mathematics curriculum in selected secondary schools in Kenya. Specifically, the study reported herein sought to determine whether there was a statistically significant difference by gender on students exposed to the computer based instruction in terms of the students' achievement, their perception of the learning environment, and their attitudes and motivation during the instructional process in the area of probability. This involved comparisons between the male and female students on all the dependent measures namely the Mathematics Achievements Test (MAT), the Students' Perception Questionnaire (SPQ), the Students' Attitude Questionnaire (SAQ) and the Students' Motivation Questionnaire (SMQ). The results infer that the CBI program resulted in significant learning gains, proper perception of the learning environment and lesson elements, better attitudes and motivation towards the topic on probability. This is statistically non significant based on the gender of the subjects. Moreover, the CBI program alleviated the problem of teaching probability that is considered difficult to teach and learn, and hence provides better opportunities for equal students' participation and interaction. In this regard, it is concluded that computer based interventions improve teachers skills in teaching and students understanding of concepts that have high cognitive demand irrespective of students gender. It is thus recommended that the CBI program be integrated in the teacher training curricula and instructional process in the classroom.

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#### **INTRODUCTION**

Mathematical knowledge and understanding is important not only for scientific progress and development but also for its day to day application. The fundamental role of mathematics lies in its daily application in most applied and social sciences, military, aerodynamic advancements, government, business, management studies and house hold chore (Cockroft, 1982; Mutunga and Breakel, 1992). Scopes (1973) and Mondoh (2005) concur to outline the four basic goals of teaching the subject as utilitarian, personal, economic and cultural. Therefore, mathematics in our society is training in itself, where development of new techniques and concepts must have scientific, economic and sociological consequences akin to the development needs of the society. This is partly the reason why mathematics is compulsory in the school curriculum in Kenya (Republic of Kenya, 1999). The Kenya Institute of Curriculum Development emphasizes that specific concepts and skills must be mastered by students at the secondary school level (Kenya Institute of Education (KIE), 2002).

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This includes measurement, statistics, probability, scale drawing and calculus. Such concepts and skills are useful and have wider application in other subjects like physics, chemistry, biology and geography (Kenya National Examination Council (KNEC), 2000). However, the general performance in mathematics among secondary school students in Kenya has remained poor for many years (KNEC, 2006; 2008). An analysis of the Kenya Certificate of Secondary Education (KCSE) examinations question papers and reports indicate that questions on probability keep recurring year after year yet no remarkable improvement has been realized in terms of students' performance (KNEC, 2008). This poor performance trend observed in mathematics has been attributed to many factors with poor teaching methods at the top of the ladder. This is blamed on the predominant use of teaching techniques in schools which are expository in nature (Kiboss, 2002; Ndirangu, 2000; Tanui, 2003; Too, 2007; Wanjala, 2005; Wati, 2011; Wasike, 2013; Nandwa, 2016; Wekesa, 2003). While such techniques provide more information to the learners in a given time, they encourage rote learning, passiveness and decline in attention as well as promoting lack of individualized instruction, and limited learner-learner and learner-teacher interaction (Wasike, 2013;

Ndirangu *et al.*, 2005). This may negatively affect the learner's beliefs and attitudes about mathematics. Consequently, many students fail to perform well in the subject because of their inability to understand and organize material sufficiently in the time allowed for study and retention. This means that the country may not achieve the Kenya Vision 2030 and the millennium development goals, for which mathematical knowledge is necessary.

Several interventions have been made by stakeholders and development partners like the Strengthening Mathematics and Science in Secondary Education (SMASSE), the New Partnership in Africa for Development (NEPAD) and the Kenya Education Sector Support Program (KESSP). All these initiatives are aimed at improving the teaching of mathematics and science subjects. The initiatives have focused on improving the teachers' skills in teaching so that concepts that have high cognitive demand are best learned by students. Despite these initiatives, the poor performance trend has continued. Literature suggest that one problem facing the instruction process in Kenya is the need to improve students' learning outcomes in a subject that impacts poorly on students learning especially in science-based subjects (Kiboss, 1997; Ndirangu, 2000; Wekesa, 2003; Wasike, 2003; Wasike, 2013; Wanjala, 2005). It is not clear if poor performance in mathematics is related to lack of teaching resources, poor teaching strategies, and the abstractness of the mathematical concepts or other such related factors. In this regard, computer based interventions have shown great potential for those areas of science and mathematics that are difficult to teach by traditional methods or where students interest is lacking.

The Computer-Based Instruction (CBI) is an area that has been recently lauded for its capability to foster the teaching of concepts and skills that are otherwise difficult to teach using the regular techniques (Kiboss, 2002; Tanui, 2003; Wanjala, 2005; Wati, 2011; Wasike, 2013; Wekesa, 2003). The use of CBI is perceived to enhance students understanding of mathematical concepts. The computer can be a good instrument in fostering interpersonal relationships as well as creativity in students and in assisting teachers to effectively teach in a more successful manner. Computers can play a vital role in making the subject matter real, dynamic, and engaging for students. They can offer students a collaborative environment and the opportunity to explore and try out alternatives in problem solving. A study was therefore designed to explore the instructional potential of the CBI in mathematics instructional process on the topic of probability whose objective was to investigate the effect of a computer based instruction program on students' learning outcomes on the topic of probability among Kenyan secondary schools. Specifically, the study sought to determine whether there was a statistically significant difference by gender on students exposed to the computer based instruction in terms of the students' achievement, their perception of the learning environment, and their attitudes and motivation during the instructional process in the area of probability

## MATERIALS AND METHODS

A quasi-experimental approach was employed to randomly assign 157 students in their intact class streams to two groups that were randomly selected from co-educational schools with computers. This was because schools chosen for the study could not allow intact classes to be split as this would interfere

with the established ambience of the existing class streams. Moreover, school authorities do not permit random selection of individual students to be broken up and re-constituted for research purpose once they have been assigned to a class stream.

These research procedures were put into consideration throughout the design and development of the study because of two reasons. First, the inter-subject differences were eliminated by randomly assigning the subjects to the experimental group. Secondly, the interactive effect that could occur due to the administration of the pre-test and the experimental manipulation was eliminated by introducing another experimental group which was similar in all aspects to the first experimental group except that the pre-test treatment was controlled. Moreover, the addition of the same experimental group was used to eliminate the between-session variations that could occur between pre-test and post-tests treatments (Fraenkel and Wallen, 1998; Ogunniyi, 1992; Kiboss, 1997). To generate the required data and make comparisons between the male and female students, four dependent measures namely the Mathematics Achievements Test (MAT), the Students' Perception Questionnaire (SPQ), the Students' Attitude Questionnaire (SAQ) and the Students' Motivation Questionnaire (SMQ) were used. In developing the instruments, the existing literature on Form Three mathematics, courseware design and development, educational measurement and evaluation was consulted and several variables which are commonly used to investigate the effect of the new technology on the subjects' cognitive and affective domain were identified.

To ascertain the validity of the instruments, expert critical analysis of the test items, relevance and appropriateness of the content, and the sequencing, wording and instructions therein were assessed and improvement done. The consistency levels of the instruments were determined using Kuder-Richardson formula 21 (K-R 21). This formula was considered appropriate because it determines the reliability of an instrument by a single administration and can assess multiple response items (Kathuri and Pals, 1993). In this view, each final version of the instruments used was tested and yielded a reliability coefficient of not less than 0.75 as determined by K-R 21 formula. Accordingly, the instruments were considered suitable to make possible group predictions that are accurate enough for most purposes.

## RESULTS

The introduction of computers into the classrooms is accompanied by conflicting expectations regarding the potential effects based on gender related differences towards learning of mathematics (Linder, 1992; Ritt *et al.* (1988); Tamar, 1994). As such, it was useful to examine the extent to which gender affects the students' learning outcomes in terms of achievement, perception of the mathematics learning environment, attitude development and motivation towards the learning of probability. In this respect, the post-test mean scores obtained by the boys and girls exposed to the CBI program on the MAT, SPQ, SMQ and SAQ were compared to ascertain whether gender differences existed. The results are tabulated in the following Table. The results presented in Table 1 reveal that boys' and girl's achievement, perception of the classroom learning environment, their attitude and motivation towards the probability lessons were similar on all

the measures. However, these results do not show if there is any significant difference. As such a further analysis using an Analysis of Variance (ANOVA) test was performed and results reported in the subsequent tables.

**Table 1. Post-test Mean Scores of MAT, SAQ, SMQ and SPQ by Gender**

TEST	Male (N = 82)		Female (N = 75)	
	Mean	S.D	Mean	S.D
MAT	66.68a	10.78	65.42a	10.4
SAQ	72.82b	10.68	72.24b	10.63
SPQ	77.45c	10.98	77.50c	10.42
SMQ	77.25d	10.12	77.98d	10.99

a,b,c,d respectively are identical

**Table 2. ANOVA Results of the Post-test Scores on MAT by Gender**

SOURCE	DF	SS	MS	F
Between Groups	2-1=1	5.29	5.29	0.30ns
Within Groups	157-2=155	2743.40	17.70	
Total	156	2748.69	22.99	

**Table 3. ANOVA of the Post-test Scores of the SPQ by Gender**

SOURCE	DF	SS	MS	F
Between Groups	2-1=1	40.29	40.29	0.08ns
Within Groups	157-2=155	7476.40	52.08	
Total	156	8112.69	92.37	

**Table 4. ANOVA of the Post-test Scores of the SAQ by Gender**

SOURCE	DF	SS	MS	F
Between Groups	2-1=1	2.29	2.29	0.03ns
Within Groups	157-2=155	9231.0	79.56	
Total	156	9234.29	82.05	

**Table 5. ANOVA of the Post-test Scores of the SMQ by Gender**

SOURCE	DF	SS	MS	F
Between Groups	2-1=1	32.29	32.29	0.28ns
Within Groups	157-2=155	8827.25	56.95	
Total	156	8859.54	89.24	

The results shown in Tables 2 - 5 reveal that the mean scores of the boys and girls do not differ significantly at  $\alpha = 0.05$  level since all the F ratios are less than the critical value. This indicates that the subjects' gender had no statistically significant influence on the subjects' performance on the MAT, SPQ, SMQ and SAQ. Therefore it has been established that the improved understanding of probability, positive attitudes and motivation during the lessons, and appropriate perception of the classroom environment is attributed to the CBI instructional conditions and not to gender.

## DISCUSSION

The foregoing presentation shed light on the themes that were investigated in this study on the effect of the CBI program on students' perception of the classroom environment, interaction patterns and their attitudes and motivation. The implication from the above results and interpretation suggests that the CBI exerted a more positive influence on the subjects' attitudes and motivation towards the mathematics course. In support of these findings are earlier discussions by Kulik and Kulik (1991), Voogt (1993), Bangert-Drowns *et al* (1990), Beichner (1994), Riddle (1995), Kiboss (1997, 2002), Wati (2011),

Wanjala (2005), and Wekesa (2003). These studies confirm that students demonstrate a more favorable attitude towards learning mathematics and are highly motivated through CBI than when taught using the conventional instructional methods. In general, the findings of this study are in agreement with the views expressed in the aforementioned studies. It is clear that the results are in agreement with the earlier findings showing that the use of computers promotes positive students' attitudes and motivation. This is because computers are capable of providing opportunities for the learners to experience the thrill of chasing after the knowledge they really want. From the results on analysis of gender effects, it can be concluded that the improved positive attitude and perception was related to the CBI instructional conditions and not to gender. These findings lend support to the view that the students' achievement, attitudes and perception of science learning depend mainly on the teaching approaches used (Linder, 1992; Olugbemiro, 1991; Yalcinalp *et al*, 1995; Kiboss, 1997; Kiboss *et al*, 2004). Moreover, positive attitudes towards computer use in science education are linked more to the type of activities or task students are involved in than in any inherent gender related abilities (Yalcinalp, Geban and Ozkan, 1995).

Studies investigating the effect of CBI on male and female students have also been done. In contrast, Roblyer, Castine and King (1988) reveal that CBI slightly favours boys over girls with differences falling short of statistical significance. Closely related to the above is a study using CBI for teaching mole concept in chemistry in which no significant difference was found between sexes (Yalcinalp *et al*, 1995). A similar conclusion was arrived at in a study to investigate the relative effect of CBI on students' learning of the physics concept on measurement (Kiboss, 1997, 2000). Clark *et al* (1991) in their study observed that though girls and women showed initial hesitation, they became very pragmatic and confident users of computers with experience. Further support is by Burgo meta-analysis that indicates comparable results on post-treatment tests for boys and girls. Similarly, Kirkpatrick and Cuban (1998) and Anderson (1999) noted similar achievement scores when boys and girls had experienced a similar amount of time and type of computer experiences. However, girls were expected to achieve more when they worked collaboratively in small groups as they preferred to explore problems verbally (Harding, 1997; Mondoh, 2000). This study has shown the interactiveness of the lesson components. Contrary to earlier studies in Kenya which indicates that some students have greater interaction with their teachers than others do (Sanga, 1982), the findings of this study have placed all students in the classroom irrespective of their gender on an equal opportunity to participate fully in the lessons. This is in line with KNEC reports (2006, 2008), Ministry of Education (2001) and Ministry of Education (1993) who have made similar suggestions by advising teachers to simplify complex concepts for students to comprehend.

## Conclusion

The pace of technological advancement in the world in general and in educational setting in particular is on the increase. In Kenya, the government is embracing technology as seen in its vision 2030. The Ministry of Education has embarked on the infrastructural development in schools in readiness to embracing technology in the instructional process. The findings of this study provide a starting point and part of the

database in this direction. Specifically, the study recommends that teacher training programs should be restructured so as to incorporate computer studies in order to enable teachers to use CBI technology. This ought to be integrated in the curriculum especially in mathematics instruction so as to facilitate educational reforms and change the teachers' position in instructional practices from that of a dispenser of knowledge to a facilitator. The general performance in mathematics among secondary school students in Kenya has been poor for many years. The findings of this study reveal that the use of computer based instructional program enhances higher ability in learning to both gender. This study recommends that mathematics teachers should make every effort to produce or obtain appropriate and well-articulated computer programmed instructional materials and use them in their lessons. The use of computer-based instruction also enhances positive students' attitude and motivation towards the mathematics course. It is therefore recommended that whenever the matter at hand requires positive students attitude towards the subject (mathematics) and a high level of motivation for effective learning, then the teacher should embrace the use of computer based instructional programs in their lessons.

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