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Effects of Computer Based Mastery Learning on Secondary School Students' Motivation to Learn Biology by Gender

Peter K. Ronoh[1*] Monicah Ndonga[2]
1.Mengit Secondary School P.O BOX 51, Longisa Kenya.
2.Egerton University P.O BOX 536, Egerton Kenya
* E-mail: peter.kipkoech.ronoh@gmail.com

Abstract
The knowledge of biology is applied in many fields including industry, agriculture, biotechnology, medicine and environmental conservation. It has a significant role to play in enhancing the country's socio-economic development by enabling exploitation of land, animal and other natural and human resources. Inspite of this, the overall achievement in biology in Kenya Certificate of Secondary Examination (KCSE) has been low. Approaches used in the instructional process have been identified as among the factors contributing to the problem of low achievement. In this study an attempt was made to overcome this problem by using Computer Based Mastery Learning (CBML) approach as an intervention to investigate its effects on students' Motivation to learn. A non-equivalent Solomon's Four Group design (quasi-experimental research design) was used in which four co-educational secondary schools were purposively sampled. The four schools were randomly assigned to four groups. Students in all the groups were taught the same biology content. Teachers of the experimental groups taught using CBML approach while teachers of the control groups taught using the conventional methods. The study focused on the topic Respiration and involved a sample of 167 Form two students in four schools in Bomet District. Students' Motivation Questionnaire (SMQ) was used to collect data. The instrument was validated by five research experts in Science Education and five practising high school biology teachers. Reliability was estimated using Cronbach's alpha coefficient. A reliability co-efficient of 0.79 was obtained. t-test was used for data analysis. Hypothesis was tested at an alpha level of 0.05. The findings indicate that there is no gender difference in motivation when CBML is used. It is recommended that CBML teaching strategy be incorporated in teacher education programes. Designers of computer based learning programmes should also be encouraged to include CBML to enhance student learning.
Keywords: Computer Based Mastery Learning, Student's Motivation, Learning Biology, Gender.

Introduction

Biological knowledge has been used throughout the centuries because it has a wide range of applications in many aspects of human life. It's applications in genetic engineering has resulted in the production of high yielding plant and animal species. This has made tremendous contribution towards meeting the demand of food requirements for the ever growing human population (Keraro, Wachanga & Orora, 2007). Biological knowledge has also been applied in branches of medicine such as organ transplant and control of a wide range of diseases. Other areas where biological knowledge has been applied include population control and environmental conservation (UNESCO, 1986).

Secondary school biology enables learners to acquire knowledge and skills useful in every day life and in development of desirable attitudes (Brown, 1995). According to UNESCO (1975), school biology should be relevant to real life and experiences of learners. There is need to change from closely directed learning of facts to conceptual understanding and application of acquired knowledge and skills to solve emerging problems. Students leaving high school should be able to use biology in their daily activities (Rose, 1971; Orora, Wachanga & Keraro, 2005). For this to be realized, effective teaching approaches that enhance learning need to be developed and used in the teaching of biology. Expository approaches cannot stand up to the challenges of the new demands and objectives of biology education hence a fresh look at new approaches should be taken (UNESCO, 1986). In recent years, science educators have used the constructivist approach to enhance students' learning (Trowbridge, Bybee & Powell, 2004). According to Good and Brophy (1995) learners' are seen not just as accessing information but also as constructing their own meanings. Aslop and Hicks (2001) point out that learning of science is essentially an active process. Therefore the teaching of biology should enhance active learner participation.

The actual outcomes of instruction depend largely on what happens in classrooms. If scientific knowledge is presented in terms of proven facts and absolute truths readily communicated through texts and lectures, then students will come to regard science as a static body of knowledge that is founded on well-defined methods (Roth & Roychoudhury, 2003). Knowledge, for these students, consists of memorizing a body of information for later retrieval. If, on the other hand, students actively engage in science processes, they recognize that scientific knowledge is based on experiments in which the meaning of data is negotiated and theories are not absolute. Knowledge, in this context, consists of learning experimental methods and the norms and practices of

scientific communities as much as it does learning known facts and current theories within a domain (Wheeler, 2000).

In teacher-centred instruction, learning focuses on the mastery of content, with little development of the skills and attitudes necessary for scientific inquiry. The teacher transmits information to students, who receive and memorize it. Assessments of knowledge typically involve one right answer. The curriculum is loaded with many facts and a large number of vocabulary words, which encourages a lecture format of teaching (Leonard & Chandler, 2003). In contrast, in a student-centred curriculum, learning science is active and constructive, involving inquiry and hands-on activities. The goal is to develop critical thinking and problem-solving skills by posing and investigating relevant questions whose answers must be discovered. The teacher acts as a facilitator, creating the learning conditions in which students actively engage in experiments, interpret and explain data and negotiate understandings of the findings with peers. In this approach, the teacher puts less emphasis on memorizing information and more emphasis on inquiry and hands-on activities through which students develop a deeper knowledge and appreciation of the nature of science (National Research Council, 1996; Singer, Marx, Krajcik & Chambers, 2000). Thus when learners are actively involved during the instructional process, their motivation to learn would improve.

Computer based instruction (CBI) provides individualized instruction and therefore learning occurs at learners own pace and time frame (Curtis & Howard, 1990; Munden, 1996). CBI enhances learning and improve retention rate of students. Coller (2004) indicated that instruction supplemented by properly designed CBI is more effective than instruction without CBI. Alessi and Trollip (1991) emphasized that there are four major types of CBI programmes namely: Tutorials, Drills and practice, instructional games and simulations.

Kiboss, Tanui and Nassiuma (2003) observed that the use of CBI Simulation has proved successful in teaching difficult concepts in Physics, Biology, Mathematics and Geography. No empirical research has specifically examined the dynamics of one to one computer tutorials and their effects on solving related problems (Hepper et al., 1993). Using the tutorials, students internalized the concepts presented. It is on this basis that CBI tutorial was adapted in this study.

Mastery Learning Approach (MLA) is an instructional method where students are allowed unlimited opportunities to demonstrate mastery of content taught (Kibler, Cegala, Watson, Baker & Miler, 1981). MLA involves breaking down the subject matter to be learned into units of learning, each with its own objectives. Results from research studies on MLA shows that there is better retention and transfer of material, yields greater interest and more positive attitudes (Wachanga & Mwangi, 2004).

In this study, the elements of mastery learning were incorporated into the CBI tutorial. The tutorial used the visual basic language. Lessons were presented using computer and students went through the tutorial in the topic respiration. At the end of each objective in the lesson were quizzes. The students were required to answer and upon attaining 80% they could be allowed to move to the next topic. This approach was referred to as Computer Based Mastery Learning (CBML). This study sought to establish whether there were any gender disparities in motivation to learn.

Theoretical Framework

Constructivism is the theoretical framework that guided this study. Constructivists believe that what gets into the mind is not transmitted or poured by some external manipulator but has to be constructed by the individual through knowledge discovery or social interaction. Learning takes place when individuals participate actively in meaningful activities. They construct both a mechanism for learning and their own unique version of knowledge, coloured by background experiences and aptitudes (Roblyer & Edwards, 2000; Hsu, Chen & Hung, 2000).

From the constructivist perspective learning is an active process in which each learner is engaged in constructing meanings whether from text, dialogue or physical experiences (Osborne, 1983). Active learning occurs when learners are challenged to exert their mental abilities actively while learning (Hout-wolters, Simons & Volet, 2000). Learners are actively seeking meaning (Kirschner, Martens & Strijbos, 2004) and are expected to be the architects of their own learning (Glaser, 1991).

Dwyer (1991) asserts that this approach is learner centered rather than curriculum centered. CBML which is interactive would enable learners to control the pace and sequence of their learning is tied to this theory (Drillscol, 2000). In CBML learners study the lesson on their own with the guidance of the teacher and answer the assessment questions at the end of the lesson unit. They are allowed to proceed to subsequent unit upon attainment of eighty percent (80%), otherwise they repeat until they attain the standard percentage this will enable the learners to construct their own knowledge.

Conceptual Framework
Figure 1 shows the conceptual framework that guided the study.

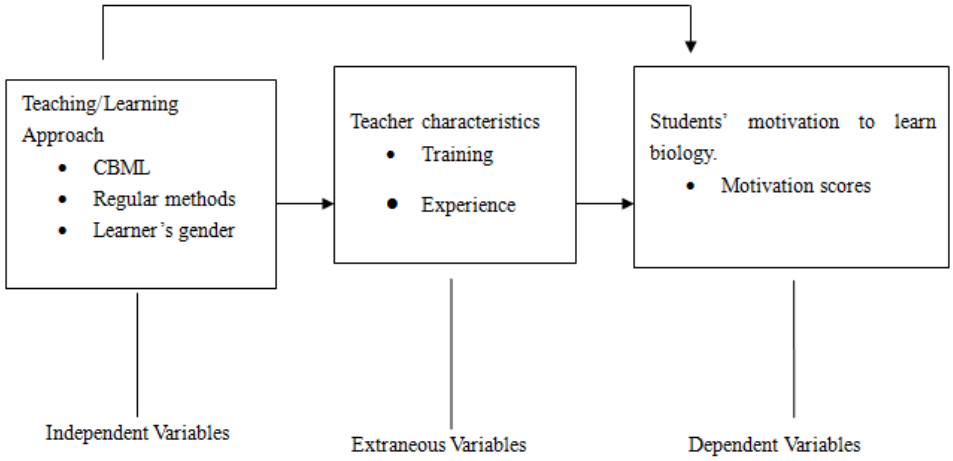

Figure 1: Conceptual Framework for Determining the Effects of using CBML Teaching Approach on Students' Motivation towards Learning Biology.

The conceptual framework shows CBML as an intervention in the teaching/learning approach of biology topic respiration, which aid motivation in the subject. The dependent variable in this study is the student's motivation towards the topic respiration. The independent variables are CBML, regular teaching methods and gender. The extraneous variables are teacher's training and experience. Teachers training was controlled by using teachers trained to teach biology at secondary school level with a minimum qualification of Diploma Certificate. Teacher's experience was controlled by using teachers who have been teaching biology at secondary school level for at least three years.

Purpose and objectives of the Study
This study sought to compare boys' and girls' motivation when taught using CBML. Its specific objective was to find whether there is a gender difference in motivation to learn biology between students exposed to CBML.

Hypothesis of the Study
To achieve the objective of this study the following null hypothesis was tested.
There is no statistically significant gender difference in motivation to learn biology when students are exposed to CBML.

Research Design
This study used the Solomon's Four non-equivalent control group design. This design is appropriate for experimental and quasi- experimental studies (Wachanga & Mwangi, 2004; Keter & Wachanga, 2013). The design overcomes external validity weaknesses found in other designs and also provides more vigorous control by having two control groups as compared to other experimental designs (Koul, 1984). This design involves a random assignment of intact classes to four groups. The study adopted a quasi- experimental design, as the subjects were already constituted and school authorities don't allow reconstitution for research purposes (Borg & Gall, 1989). The design is shown in figure 2.

E_1	O_1	X	O_2	Experimental group
C_1	O_3	-	O_4	Control group
E_2	-	X	O_5	Experimental group
C_2	-	-	O_6	Control group

Key: Pre-tests: O_1 and O_3; Post- tests: O_2, O_4, O_5 and O_6; Treatment: X
Figure 1: Non-randomized Solomon's Four- Group, non- equivalent control group design

Sampling Procedures and Sample Size

A sample of 167 subjects was used. Purposive sampling was used to select four secondary schools which offer computer as one of the teaching subjects. Four schools were chosen because each school formed a group in the Solomon Four Group Design so that the interaction is minimized during the exercise. The selection of the schools and assignment of one form two stream per school selected to either experimental or control groups was done using simple random sampling. Balloting was used; this entailed assigning serial numbers to form two streams of the participating schools and picking one at a time respectively.

Instrumentation

Students' Motivation Questionnaire (SMQ) was used to measure the learners' motivation to learn biology. The researcher adapted and modified the SMQ developed by Kiboss (1997) to suit the current study. The instrument had 20 items. The items were constructed on a five point Likert scale. The responses to questions include strongly agree, agree, undecided, disagree and strongly disagree. All the choices were abbreviated as SA, A, U, D & SD respectively. SA was assigned 5 points where else SD was assigned 1 point. The items tested interest and confidence towards learning biology. The rating scale's minimum score was 20 marks and the maximum was 100 marks. The instrument was validated by research experts in Egerton University. The Cronbach alpha coefficient was used to estimate their reliability. A reliability coefficient of 0.79 was obtained.

Development of Instructional Materials

The researcher developed an instructional manual for the teachers involved in the use of CBML. The manual focused on objectives, content to be covered in the topic and teaching/learning activities. The manual was based on revised KIE, (2002) biology syllabus. Teachers of the experimental groups were trained by the researcher on how to use CBML for four days. This was to enable them master the skills of using CBML approach.

Data Collection Procedures

Research permit was sought from the National Council for Science and Technology (NCST) through the Director, Board of Post Graduate Studies of Egerton University. Prior to the start of the topic, the experimental groups E_1 and E_2 had to undertake an orientation course using the CBML manual under their teachers' supervision to familiarise with the computers and the CBML software. The Students' Motivation Questionnaire (SMQ) was administered to the experimental group (E_1) and control group (C_1) as a pre-test.

The experimental group E_1 and E_2 were taught using CBML approach within a period of two weeks with the help of cooperating biology teachers while control groups C_1 and C_2 were taught using the regular methods of teaching. Students' Motivation Questionnaire (SMQ) was administered as a post test to all the four groups at the end of the topic respiration. Scores were coded and quantitative data generated that was then analysed.

Data Analysis

Data was analysed using t- test with the help of statistical package of social sciences (SPSS). A t-test was used to test differences between the pre-test mean scores because of its superior quality in detecting differences between two groups (Borg & Gall, 1989). Tests of significance were performed at alpha level 0.05.

Results

To establish whether the experimental (E) and the control groups(C) were similar at the beginning of the study the pre-test scores of SMQ were analysed using independent sample t-test. The results are shown in table 1

Independent sample t-test of pre-test scores on SMQ based on gender

Scale	Gender	N	Mean	*SD*	*df*	*t*-value	*P*- value
SMQ	Male	50	2.83	0.43	78	1.026	0.308
	Female	30	2.73	0.36			

Table 1 shows that the pre-test mean scores in SMQ for males was (M =2.83, SD = 0.43) while for females was (M = 2.73, SD = 0.36), t (1.026) = 0.308, p>0.05. This shows that there was no significant difference in motivation to learn biology between male and female students.

Effects of Gender on motivation to learn biology

To find the gender difference on motivation when students were exposed to the CBML approach, the SMQ mean scores for male and female students were computed and then compared to determine whether there were significant differences, the results were also compared with those of control groups. The results are shown in table 2.

Table 2
Post-test SMQ mean scores and independent sample t-test for male and female students exposed to regular teaching approaches.

Gender	N	Mean	*SD*	*df*	*t*-value	*p*- value
Male	18	25.89	7.23	35	0.002	0.963
Female	19	26.95	7.69			

Table 2 shows post-test SMQ mean scores and the independent sample t-test for male and female students exposed to regular teaching approaches. A comparison of the two scores using a t-test yielded a t (35) = 0.002, $p > 0.05$. This, therefore means that there is a statistically significant gender difference in motivation to learn biology when students are exposed to regular teaching approaches. This is because teachers tend to give more attention to female students than male students. To establish whether there is gender difference when male and female were exposed to CBML t-test was carried out. The results are shown in table 3.

Table 3
Post-test SMQ mean scores and independent sample t-test for male and female students exposed to CBML approach.

Gender	N	Mean	*SD*	*df*	*t*-value	*P*-value
Male	39	3.50	0.52	71	0.807	0.422
Female	34	3.41	0.51			

Table 3 shows post-test SMQ mean scores and the independent sample t-test for male and female students exposed to CBML. A comparison of the two scores using t-test yielded a $t(71)=0.87, P > 0.05$. These, therefore means that there was no gender difference in motivation to learn biology at the end of the CBML intervention. The hypothesis which states that there is no statistically significant gender difference in motivation to learn biology when students are exposed to CBML approach was therefore accepted.

Discussion

Effects of Gender on Motivation to learn biology

The Motivation mean score for boys who were exposed to CBML was found to be 3.50 while the mean score for girls also exposed to CBML was 3.41. The difference between the two means was found not to be statistically significant $t(71) = 0.807$ $p>0.05$. This indicates that girls were as equally motivated as boys to learn during the treatment period.

Wachanga, (2002) notes that in regular teaching male and female teachers give more attention to boys than to girls in secondary schools. This makes teachers more likely to use positive reinforcement on boys than they do on girls. This practice makes girls feel that they are less capable compared to boys. In his study the effects of traditional and cooperative class experiment teaching methods on students' achievement and motivation in chemistry were compared. The findings were that cooperative class experiment as a teaching method enhanced girls' confidence in learning chemistry. Girls' motivation was comparable to that of boys and no statistically significant difference was found (Wachanga, 2002). Wachanga ensured that teachers gave equal attention to boys and girls during teaching and reinforcement was uniform. He also ensured that there was positive interdependence and individual accountability in the learning process. Wachanga's findings, therefore, support the findings of the current study in regard to motivation of learners.

In this study, boys and girls of mixed abilities were placed together in different groups and all were treated equally by their teachers. Every student was given an equal chance to contribute during the biology lessons (Johnson & Johnson, 1992). This made girls feel that they were also capable and raised their motivation. The CBML teaching approach, therefore raised the level of motivation of girls to learn biology.

Conclusion

Based on the findings of the current study, the following conclusion has been reached. There is no gender difference in motivation to learn biology when students are taught using CBML approach.

Implications of the study

The findings of this study have indicated that the use of CBML in the teaching of biology in secondary schools results in higher students' motivation to learn biology. When this approach is used, the students' gender does not affect their motivation to learn. This would, therefore, imply that its incorporation in teaching would boost the learning of biology in schools. This in turn would improve the low achievement at KCSE biology examinations.

Educational administrators and designers of computer based learning programmes should emphasize the use of CBML in biology lessons and possibly other science subjects in their effort to boost students' motivation. This will in turn lead to better achievement in biology. Teacher training institutions such as universities should also incorporate the CBML concepts in their training curriculum in order to empower teachers to use the new approach.

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