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COMPARISON OF TEST SCORES OF SECONDARY SCHOOL LEARNERS ASSESSED UNDER CONCEPT MAPPING AND BIOLOGY ACHIEVEMENT TEST (BAT) AS MEASURING INSTRUMENTS OF QUALITY IN KENYA

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Abstract

Despite the importance of knowledge of biology, candidates' performance at national examinations is poor. This implies that the quality of education low though access is satisfactory. Poor academic performance of learners is usually attributed teaching methods. However, examination methods are often ignored yet their effect could be significant too. The purpose of this study was to compare differential effectiveness of two assessment tools Concept Mapping(CM) and Biology Achievement Test(BAT) on learners/academic achievement in secondary school education. The study was quasi-experimental using non-equivalent control group design with 4 groups. 2 of the groups comprised boys while 2 were for girls to allow for investigation for gender. The accessible population was all students in national schools of which 20 were sampled. The students in the 4 schools were taught the same topic in biology: "general characteristics of enzymes" and were assessed using the two measuring instruments in equal proportion. Before commencement of teaching, pre-test was given as post-test after re-arrangement of test items was done. The test had 25 objective questions testing knowledge of facts, application of knowledge and problem solving ability. Data analysis was done using ANOVA. In order to test the hypothesis at significant level of 0.05. The results and findings of the study shows that use of Biology Achievement Test (BAT) led to higher mean scores compared to use of concept maps. This difference could be attributed to lack of adequate skill and experience by learners in constructing good concept maps. The findings of this study could be helpful to curriculum developers and teachers in an effort to comply with the newly launched Competency–Based Curriculum (CBC) framework in Kenya.

Index Terms: Comparison, Test Scores Of Secondary School Learners, Concept Mapping, Biology Achievement Test, Measuring, Quality and Kenya

I. INTRODUCTION

Biology Education has both intrinsic and extrinsic justifications (Brown, 1995). The former relates to advancement of Biology for its own sake as a discipline while the latter is concerned with the promotion of societal welfare. Inferably, the teaching and learning of Biology plays both academic and social roles. Killermann (1998), explains that the academic role concerns the acquisition of scientific knowledge, skills and attitudes for application in the fields of medicine and agriculture among others. The social role pertains empowerment of students in economic and technology related areas.

The overall goal of teaching Biology in Kenya is to make learners to fully understand themselves and the environment (Maundu, Sambili & Muthwii, 1998). In addition, it enables students to appreciate mankind as part of the broader community of living things. Biology is also a precursor of Biotechnology, which is a vital tool for technological and industrial development. The teaching of Biology therefore, aims at the production of a scientific community whose major role is to promote the welfare of humankind through application of knowledge of Biology. In addition, Biology fosters the advancement of science through research and publications (Lawson, 2001).

Since independence, efforts have been made to improve standards of teaching Biology in Kenya through educational reforms but the examination system has largely remained the same. Maundu, Sambili & Muthwii, (1998) reports that, the African Curriculum Development Centre (ACDC) established in 1963 made the first attempt at improving the teaching of Biology, The ACDC later became The Kenya Institute of Education (KIE) in 1974 and is now The Kenya Institute of Curriculum Development (KICD), since 2013. However, the ACDC project failed because of reasons that ranged from teachers' incompetence, to lack of teaching resources in schools. The United Nations Educational, Scientific and Cultural Organisation UNESCO pilot project (1967) saught to change teaching methods for Biology but also failed due to various constraints including upholding of the examination system that was in place by then. Similarly, the Nuffield Science Projects in Kenya (1969), did not succeed to achieve its objectives. The traditional Biology syllabus, Human Biology and the School Science Project (SSP) Biology of the 1970s' all of which were examination-oriented, persisted until the introduction of the 8-4-4 secondary school Biology in 1986. The 8-4-4 Biology syllabus has also undergone several changes since then (KIE, 1992; KIE, 2002; KIE, 2006).

In an attempt to achieve objectives of the Secondary School Biology syllabus, KIE (2006) has suggested several methods of teaching. However focus on teaching methods alone may not not yield much if the examination system remains unchanged. In a study, Orora, Wachanga and Keraro (2005) found that the cooperative Concept Mapping teaching method enhanced achievement and motivation in secondary school Biology in Gucha County, Kenya. Concept Mapping technique if used for assessment purpose could also perhaps boost learnres' academic performance.

According to the Kenya National Examination Council (KNEC) reports, the KCSE mean scores in Biology for the period 2007 to 2010 were as follows: 2007- 44% ; 2008- 30%

; 2009- 27%; 2010- 29%; 2011- 32% and 2012-26%). Accordingly, performance was influenced by many factors but the magnitude of each factor is not known. The major factor could be in the examination system of the Biology subject in relation to the learning outcomes. However, this is very speculative.

II. Statement of the Problem

Despite the government's effort to review curriculum as well as change the examination format, student performance in the KCSE Biology National examination continues to decline. Low achievement in Biology at KCSE examinations may imply that the information taught is not sufficiently acquired for general use in life. Many studies have been carried out in Kenya and elsewhere to compare effects of teaching methods on academic performance. Most of these studies observed that teaching methodology is a crucial factor in determining academic performance of students. Mills (1991), observes that the teaching methodology is a crucial factor that affects academic achievement of students. Esra et al. (2009) allude that the sequence of teaching methods affect performance. However, studies addressing the effect examination techniques have not been been carried out under Kenyan conditions where other factors affecting performance also exist. This study aimed at addressing that paucity of information. Therefore, the research problem focused on how the usage of Cocept Maps would be comparable to that of the Biology Achievement Test that is commonly used to measure academic achievement at secondary school level in Kenya.

III. Research Objectives

The purpose of the study was to compare performance of students who were examined using Concept Maps and Biology Achievement Test as Instruments for measuring learners' academic achievement.

Specifically, the study sought to compare the effectiveness of Concept Map and Biology Achievement Test (BAT) as tools to measure academic achievement.

IV. Theoretical, Conceptual Framework and Hypotheses of the Study

The theoretical framework provided the foundation on which the study was based. While the conceptual framework was guided by the experiences and intuition of the researcher. The conceptual framework presented an elaborate network of associations among the relevant variables of the study.

Theoretical Framework

This study was guided by the constructivist theory of learning proposed by Jean Piajet among others. The constructivist theory holds that the learner constructs knowledge from experience which, is unique to each individual. The theory suggests that learning is an active process in which the learner is physically and mentally engaged in constructing meaning from text or experiment. According to this theory, learning outcomes depend on the learning environment as well as learner's prior knowledge (Novak,1998). Learning does not only occur through taking in of new information but also involves reorganisation and imaginative reconstructing of the conception or frameworks which learners are already familiar with. The construction of meaning is a continuous process,hence need for continous assessment. Knowledge is therefore not a ready –made transferable product but rather a product of the learners' thinking (George,1999).

The study was also based on the Cognitive Load Theory of learning by Sweller (1994). According to this theory, the human working memory has a threshold of 4 to 10 elements making some material difficult to learn. Sweller (1994), provided evidence that the cognitive load of some learning material can be greatly reduced if the information is presented pictorially as is the case in Concept Mapping.

Conceptual Framework

Several factors or variables interact and affect learning. The variables could be categorised as extraneous, independent and dependent. These variables and their interactions constitute the conceptual model of this research.The conceptual framework that guided this study is based on a Systems Approach. According to a Systems Approach, the teaching and learning process has inputs and outputs (Joyce & Weil, 1980). Therefore, in order to achieve good academic results, the output should be assessed using suitable methods in addition to having appropriate instructional methods.

Learning outcomes are influenced by several factors. These included both learner and teacher characteristics which, constituted extraneous variables that had to be controlled. The learners' age determines what they are to be taught. The qualifications and training of the teachers on the other hand determine their competence and capacity to effectively handle the subject matter at a particular class level. In addition, training can affect the the instructional and assessment procedures a teacher would prefer to use more often and how effective the teacher would use the approach. Gender was an extraneous variable which could not be controlled but whose effect could also not be ignored. It was therefore investigated. In order to investigate the effect of gender, The researcher categorised learners into groups; two comprising girls only, and two of boys only.

Professionally trained Biology teachers who had also gone through the SMASSE in-service training programme were used to control for the variation in teacher qualifications. In this study therefore, the assessment method used was regarded as the only variable that could influence the learning outcomes. The conceptual framework shows the relationship of variables for determining the effects of using Concept Mapping and Biology Achievement Test methods on secondary school students' performance in Biology. The framework is represented diagrammatically in Figure 1.

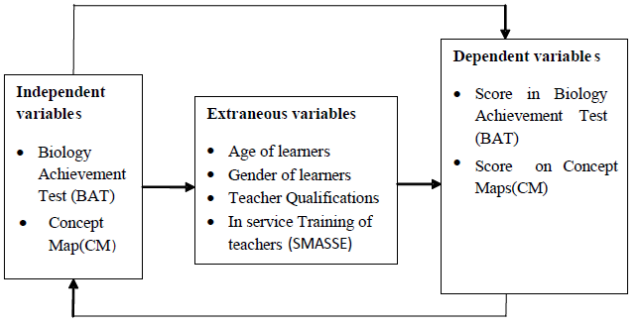

Figure 1. The Conceptual Framework

V. RESEARCH METHODOLOGY

This study was quasi-experimental, using the Non-equivalent Control-Group eight study design. It was found suitable for controlling all the threats to internal validity. All the eight observations made were used to generate estimations of the effect of the experimental treatment, interactive testing variables and that of the control variables. The general model of the study design is represented in Figure 2.

Group I (B)	O1	X	O2,
Group II (G)	O3	X	O4
Group III (B)	O5	X	O6,
Group IV (G)	O7	X	O8

Figure 2: General Model of the Non-equivalent Control-Group eight Study Design

Source: Adapted from Tables 8.3 and 8.4 in John W.Creswel, "Research Design, 3rd edition, Sage Publications New Delhi, 2011. pp 160

Where: O1, O3, O5 and O7 are pre-tests using BAT
O2, and O4, are post-tests using Concept Mapping
O6 and O8 are post-tests using BAT

X is the treatment where students were taught using Concept Mapping approoach.

B is Boys only school.

G is Girls only school.

Group I (B) received the pre-test, the treatment (taught using Concept Mapping approach), the post-test (using Concept Mapping approach).

Group II (G) received the pre-test, the treatment (taught using Concept Mapping approach), the post test (using Concept Mapping approach).

Group III (B) received the pre-test, the treatment (taught using Concept Mapping approach), the post test (using Biology Achievement Test).

Group IV (G) received the pre test, the treatment (taught using Concept Mapping approach), the post test (using Biology Achievement Test).

Quasi experimental design was used because the classes were naturally formed in the school and remained intact during the study, a view supported by (Creswell, 2011). The study was analytical and predictive in nature; a strategy common in educational research. The research process was thus manipulative not enumerative. It was a snapshot or cross-sectional study where sufficient data was collected at one point in time. Form One classes were used as the unit of analysis.

Variables of Study

The variables were Biology Achievement Test (BAT) and Concept Mapping Strategy.They were observed and measured usin **Variables** d Concept Map scores as in indicated in the conceptual framework.

The dependent variables were learners' achievement of knowledge of Biology .These variables were observed and measured using scores obtained on BAT and Concept Maps. Their variability was established through analysis of the test scores.

The extraneous variables in this study were the age and gender of the learners, teacher qualifications and in-service training. These variables were those whose possible effects on the learning outcomes were controlled.The learners' age determines the subject topic to be covered . The qualifications and training of the teachers on the other hand determine their competence and capacity to effectively handle the subject matter at a particular class level. In addition, training can affect the the instructional approach a teacher would prefer to use more often and how effective the teacher would use the procedure.

Learners' age was controlled by using pupils from the same class level; in this case Form One. This is because the topic selected for the study is offered at Form One level.The topic was selected because of replicability considerations. In addition, the KNEC report (2006), enlist enzyme activity as a difficult topic for learners to conceptualise. It consists of many concepts involving complex relations and interactions. Representativeness of gender was ensured by having groups where half were boys and the other half were girls. Gender, though an extrenous variable, was investigated since its effect could not be ignored. Single sexed schools were thus used. Teacher qualification variable was controlled by using teachers who were holders of Bachelor of Education degree (BEd. Science Botany-Zoology option) and SMASSE trained.In-service training provided opportunity for teacers to acquire competence in use of Concept Mapping for instructional purposes. All the three types of variables descibed in this section and their interactions constituted the conceptual model of this research.

Population of the Study

All the secondary schools in the Republic of Kenya constituted the population for the study.According to the Ministry of Education, Science and Technology (2014) statistics, there were 6739 registered secondary schools in Kenya with a population of approximately 2,514,068 students. This was therefore the target student population

The accessible population was approximately 86,400 students. It comprised all the classes in Form One to Form Four in the 18 National schools. Although the schools are fairly distributed, some regions of the country had no National schools of the old category. The schools were endowed with teaching –learning resources that could affect the application of Concept Mapping approach.

Sampling Procedures and Sample Size

The types of National Schools in Kenya can be grouped into two main categories: Old category National schools established between the 1960s and 1980s.These are 18 in number. New category National schools which were upgraded from provincial status to national status in 2012.This category comprises of 72 schools.

The schools which were included in the sample were obtained from category (i) above. The unit of sampling in this study was the secondary school rather than individual students. This means therefore that each school was considered as one group. The school sample was drawn through multi-stage sampling, from 18 Old category National schools situated in Nairobi, Central, Rift Valley and Nyanza regions of Kenya. National Schools were used in the study since they are well endowed with teaching and learning resources and have similar admission criteria. These schools represent the top cream of academic power in Kenya.

First, the schools were divided into four clusters according to the regions where they are located. The 18 National secondary schools were visited to ascertain their suitability for the study. The criteria for suitability included qualifications, training and performance index (mean score) of subject of Biology for the teachers in the schools. Participating schools from the four clusters were then selected by purposive sampling after identifying schools categorised as boys schools or girls school. Purposive sampling was used to select the schools that finally constituted the sample of the study.

The procedure for selection involved the use of Table of Random Numbers for those that remained on the list after excluding the ones that were found unsuitable for the study. From the two gender strata, two boys schools and two girls schools were randomly selected making a total sample of four schools.

The four(4) schools were then randomly assigned to treatment groups. Although random assignment is not a perfect method for assuring treatment group equivalence, it is nonetheless, the best method available (Sekeran and Bougue 2011). Since most Old category National schools have more than 4 Form One streams, all the streams were given the same treatment or control conditions due to ethical reasons. However, only two streams from each school was randomly sampled for analysis.

The actual schools sample consisted of four Old Category National schools (two boys and two for girls). A participant sample of 402 learners was purposefully identified from the school sample. The reason was to cater for both gender and regional representation.

Table 1. Sample Size

Group	Gender		Total
	Male	Female	
1	102	00	102
2	00	97	97
3	104	00	104
4	00	99	99
Total	206	196	402

The sample size was determined by the enrolment in the schools selected. The selection was done on the basis of location, syllabus coverage, willingness to cooperate and gender balance.

Finally, the reseacher randomly assigned the intact groups that were chosen to the various treatment conditions. This is in line with Borg and Gall's, (1989) recommendation that random assignment controls for interaction, maturation and selection.

Instrumentation

In this study three tools were used for data collection. Two of these were adapted from previous research by Esra et, al (2009). That is, Pre-test BAT and Post-test BAT. The two tools were similar except for the arrangement and numbering of test items and could thus be considered as one tool.

This tool was designed by Esra, Ijlal and Ocak (2009). It is a standardised tool that was used in their previous study involving 60 students at Ataturk University in Turkey. This tool was adapted for the study by rearranging the questions only without any other changes. The BAT contained 25 objective questions testing the knowledge of facts and ability to solve problems. It was used to obtain quantitative data on achievement from all the learners. Every test item consisted of a "stem" and a series of responses from which the learner had to choose the correct answer. It was a one hour test that was taken by learners individually. Each of the 25 multiple choice items carried four points. The test was scored using a marking scheme. Scores were expressed as a percentage. The BAT was standardised using the Cronbach's Alpha coefficient. A table of specifications was constructed to ensure validity and balance of content as well as intellectual skills. The use of table of specifications ensured that all content areas as well as various levels of knowledge and skills are covered by the test.

Concept Maps were not structured as BAT since learners were examined on their ability to construct Concept Maps by themselves. However, a sample Concept Maps to guide marking were constructed using the 29 concepts that formed the basis of the 25 items that were contained in the BAT.

The reliability of Concept Maps was established using Pearson Correlation Coefficient and was calculated from a sample of 25 randomly picked Concept Maps. A reliability coefficient of 0.76 was established, and was an indication of high reliability.

Data Collection Procedure.

Data for this study was collected over a period of 3 months. In the first week, the researcher introduced all the four (4) groups of students to Concept Maps. The teachers of Biology attended the sessions only as observers. The purpose was for expert training of students on how to construct Concept Maps. At this stage learners were shown how to draw Concept Maps using a previously learned topic, "Chemicals of life". The goal was to familiarise the students with Concept Maps. A different but related topic was used so as to avoid pre-empting what students were to be assessed on. The researcher also trained the teachers of Biology on how to administer the treatment that was given over a period of two (2) weeks and was administered by the teachers on the topic "Enzymes". Treatment invoived teaching of students using Concept Mapping approach.After treatment, half of students were assessed using Concept Mapping strategy and half were assessed using Biology Achievement Test (BAT).The Concept Maps were scored by the researcher using a marking scheme .Data on Concept Maps scores was collected from assessment of Concept Maps.

The rationale behind choice of this test was that the concepts relate to the questions in the BAT. Furthermore, 29 concepts which were expected to be incorporated in the Concept Maps formed the basis for the 25 items that were

contained in the BAT.

The Concept Map scores were expressed as a percentage. Scores were scaled in order to comment on them easily. The scale of 1-4 was used for grading and the scores distributed as follows 1 = 1% to 25%, 2 = 26% to 50%, 3 = 51% to 75% and 4 = 76% to 100%. Grading of test scores was useful in ranking and reporting of learners' performance. The scale therefore represents performance quartiles. The frequency (rate of use) of each concept in the map was also determined to evaluate retrieval of information. Finally, the test scores of Concept Maps were correlated with the scores of BAT post-test to find out whether the two sets of measure based on the same content are comparable. This addressed Objective 4 of the study which, sought to compare effectiveness of Concept Maps and BAT as measurement tools for academic achievement.

Data Analysis and Presentation Methods

The analysis involved Two- way Analysis of Variance (ANOVA), using the univariate general linear model. The method was used to assess the mean differences between the four groups. Nassiuma and Mwangi (2004) affirm that ANOVA is a useful technique in research where multiple sample cases are involved. In this study, Gender-based test scores were also compared using an independent sample t-test. This was to establish whether there were any differences in performance between the male and female students. The Null Hypothesis was tested at the 0.05 significance level. Data collected in this study was therefore analysed based on the study hypotheses Ho1: There is no difference in scores when learners are assessed using Biology Achievement Test (BAT) and Concept Mapping strategy. Ho1 was tested using data that comprised scores of both the BAT and the Concept Maps. The adjusted means and standard error for each group were correlated to establish whether there was a relationship between BAT scores and Concept Map scores. A paired - samples t-test was used in data analysis. Data presentation method adopted in this study involved use of tables.

VI. DATA ANALYSIS, FINDINGS AND DISCUSSIONS

Results of the Pre-test

The results of performance in the Pre-test BAT administered to all the four groups prior to the treatment are presented in Table 5.

Table 5: Performance means of Four Groups Subjected to the Pre-test BAT

N	Grp	Mean	Std. Dev.
102	1	13.8	4.76
97	2	12.54	5.25
104	3	13.00	4.69
99	4	12.24	4.57

In order to compare the means of the four groups, one –way ANOVA was applied. The ANOVA results of the Pre-test BAT scores are summarised in Table 6

Table 6: Results of one-way ANOVA for the four groups subjected to pre-test BAT

	ss	df	ms	f	sign
Between Groups	140.02	3	46.68	2.01	0.112
Within Groups	9242.38		398	23.22	
Total	9382.41				

An examination of results in Table 6 shows that the mean scores of groups 1, 2,3,4 on Pre-test BAT are not significantly different ($F(3,398)=2.01$, $p>0.05$). The four groups were therefore at a comparable level of prior knowledge. An independent-samples t test was applied to compare the means of male and female students on the Pre-test BAT.

Performance by Gender in Pre-test BAT

Results of the analysis of are presented in Table 7.

Table 7: Independent Samples t-Test of the Pre-Test Scores on BAT Based on Students' Gender

Gender	Mean	Std. Dev	t. Value	p-Value
Male	12.47	6.38	0.12	0.90
Female	13.34	5.38		

Male, N= 207; Female, N= 195

An independent samples t-test comparison of the mean scores of male and female learners found no significant diffrence between the means of the two groups ($t(400) =0.12$, $p>.05$). The mean of male learners ($m=12.47$, $sd=6.38$) was not signifcantly different from the mean of female learners ($m=13.34$, $sd=5.38$). The implication is that both the male and female learners were similar with respect to prior knowledge of the topic and were thus suitable for the study. This could have also implied that both boys and girls had similar learning ability.

Results of Post-test BAT

The results are based on students' performance on Biology Achievement Test (BAT) and Concept Maps.

1	3	-	-	-8.76	.000
1	4	-	-	9.13	.000
2	2	97	49.20± 1.213	-	-
2	3	-	-	13.61	.000
2	4	-	-	22.12	.00
3	3	104	55.31± 1.321	-	
3	4	-	-	17.89	
4		99	37.41± 1.112	-	

Results of Comparison of Effectiveness of Concept Map and BAT as tools for Measuring Academic Achievement and Transfer of Knowledge

The results are given with respect to Objective 1 as well as Hypothesis 1 ($H_0 1$) which stated that there is no significant difference in scores when learners are assessed using Biology Achievement Test (BAT) and Concept Mapping technique. To test this hypothesis, Biology Achievement Test (BAT) scores of the two groups were compared with the Concept Maps Test (CMT) scores, whereby Concept Maps were used

as evaluation tool. Table 5 show means and standard deviation while results of the paired - samples t-test are summarised in Table 6.

Table 5: Means of BAT Post-test Scores &CMT Scores of Learners

	Mean	N	Std.Deviation
BAT score	47.20	402	12.49
CMT score	36.66	402	20.02

Table 6: Paired- Samples t- Test for BAT Post-test and Concept Map Scores

	t	df	sig(2-tailed)
Achievement score Concept Map score	13.17	401	.000

A paired samples t-test was calculated to compare the mean Achievement score and the mean Moncept Map test score. The mean on the achievement test was 47.20 (sd=12.49), and the mean on the Concept Map test was 36.66(sd=20.02).A significant difference between Achievement test and Concept Map test was found (t (401)=13.17,p<.05).

The null hypothesis which stated that, 'There is no statistically significant difference in scores when learners are assessed using Biology Achievement Test (BAT) and Concept Mapping strategy.' It was thus rejected.

The results in Tables 5 and 6 point to the following findings:

i. The achievement scores were higher than corresponding scores on Concept Maps.

ii. The new testing techniques (Concept Mapping) did not improve the scores.

VII. Discussion of Results

Comparison of Effectiveness of use of Concept Maps and BAT as Measuring Tools

Concept Maps and BAT were used to measure academic achievement and knowledge acquisition. Esra's 2009 work never got to analyze the knowledge structure of the students since the BAT was based upon multiple choice questions. Though the same BAT was adopted for the present study, it was necessary to understand the cognitive structure of students hence need for assessment using Concept Maps. The advantages of Concept Maps are firstly, that you can see the context of each part (concept) in relation to the whole, which increases understanding . Secondly, you will have a finite view of the subject and will more easily be aware of omissions. Thirdly, you will be able to focus on the specific parts of the subject thus create patterns which holds the required information and steps to access them. The exercise usually begins with parts and builds up to the whole. Furthermore, Concept Maps offered an opportunity for learners to use knowledge in a new context of assessment.A review of literature on Concept Map shows that it is useful in both teaching and assessment (Novak and Gowin 1984; Trowbridge and Bybee, 1996; and Rice et al, 1998).

This research was motivated in part by the persistent and growing poor performance in Biology at the KCSE examination as a clear manifestation of Poor teaching/learning strategy. Many researchers on Concept Mapping agree that it can make learners to remember information longer and be able to use it more effectively . In the Kenyan situation where the KCSE is a high-stake examination, it is prudent to explore alternative methods which will guarantee transition to higher levels of learning. Concept Mapping is one such method based on findings regarding its usefulness. Its use as an evaluation tool was thus being exploited.

One benefit of Concept Mapping is that it reveals the amount and detail of information and their linkage as contained in the students' memory. Secondly, Concept Mapping tests both information recall and relationships between the pieces of information. (Vitale and Romance 2000).

The findings of this study show that use of Biology Achievement Test (BAT) led to higher mean scores compared to the use of Concept Maps as an evaluation tool. Declining performance with use of Concept Maps could be attributed to lack of adequate skill and experience by students to construct good Concept Maps. When Concept Maps are used for instruction, they can also be used for evaluation (mintzes et al, 2000). However, Concept Maps cannot be used on national achievement examinations such as the KCSE if most students have not been given opportunities to learn to use this knowledge representation tool. Currently there are a number of projects worldwide that are doing research to see if better evaluation tools can be developed including the use of Concept Maps (Lawson, 2000).

VIII. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary of Main Findings and Contributions to Knowledge

On the basis of the data analysis presented , the following are the major findings of the study:

The achievement scores on BAT (47.12%) were higher than scores on Concept Maps (36.54%). Poor performance on Concept Maps is attributed to lack of adequate skills and experience by the students. The new testing technique did not therefore improve the scores.

Conclusion

Concept Mapping appears not to be useful in addressing the problem of low achievement in Biology at the Kenya Certificate of Secondary Education Examinations (KCSE) .It can probably be useful if learners could get more exposure to assessment using concept maps.The Kenya National Examinations Council (KNEC) could also explore ways incorperating Concept Mapping in assessment of achievement in Biology.

Recommendations

The recommendations below are given in the light of the findings and context of this study. *Recommendations at the pedagogical level*

(1) New policy guidelines to be formulated by KICD to emphasize use of Cocept Mapping as a means to improve learners conceptual understanding of knowledge of Biology.

(2) In view of the findings of this study,the existing policy should be improved so that teachers are trained or retrained on use of Concept Mapping Strategy. This could be done by the relevant government agenies or Universities, professional bodies such as KICD through workshops, seminars, conferences and training programmes.

(3) The Biological science curriculum in Kenya should

be reviewed to accommodate the use Concept Mapping strategy in content delivery as well as assessment. Consequently,more time should be allocated to Biology in the schools timetable to provide for application of Biology Concept Mapping skills.

(4) Educators should respect gender differences when assessment is done using Concept Maps rather than decrying them.

Suggestions for Further Research.

In this study one of the prevalent issues that emerged is related to lack of adequate knowledge, skill and experience in Concept Mapping during processes of learning and evaluation. Bearing in mind the students' background and their difficulties, this learning and evaluation strategy and tool itself stands in need of further research in order to address the relevance of using it both in teaching and testing.

A further investigation to explore the applicability of other mapping techniques, for example, Vee mapping, mind mapping or their combination with knowledge mapping is recommended. This would help students to effectively construct and collaboratively exchange ideas and new knowledge.

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