An Investigation Of Concept Attainment Model On Learning Achievement In Biology In Public Secondary Schools In Kibwezi Sub-County, Kenya

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ABSTRACT

Biology performance in public Secondary Schools has been quite low compared to the other sciences. This has been attributed majorly on the nature of teaching methods used, the abstract nature of biology, and the teaching-learning resources. This study sought to investigate the effect of concept attainment model on learning achievement in biology in public Secondary Schools of Kibwezi Sub-County, Kenya. There is inadequate research done on the effect of concept attainment model in the teaching-learning process in the classroom situation especially in Kibwezi Sub-County schools. The objective of the study was to establish the extent to which concept attainment model influences the level of students' understanding of biological concepts. The research was based on Burner's learning theory and component display theory. The research used a quasi-experimental design. Simple random sampling method was used to select four schools out of 52 Co-educational schools. The sample size comprised of 244 students from the four schools. Piloting was done in one public co-educational school in Makindu Sub-County. Concept attainment test (CAT) constructed by the researchers was used to collect data. It had an estimated reliability coefficient of 0.7 established through the split-half method. This CAT was administered to an experimental and control groups before the intervention was done. Data was analyzed using descriptive statistics, t-test and ANOVA through the Statistical Package of Social Sciences (SPSS) version 24. The study shows that students taught using CAM scored better and had increased the levels of understanding of biological concepts than those taught using the traditional methods. Biology educators in colleges and universities should incorporate CAM in their teacher education programmes and make it part of their curriculum also biology education stakeholders should encourage CAM in their teaching.

Key words: Concept attainment, model, learning achievement, biology

1. INTRODUCTION

Biology as a natural science is concerned about the study of life and life processes of living organisms. Its practical skills equip students with concepts, skills and ideas that are useful in solving the day-to-day problems about life. The study of Biology aims at equipping learners with the necessary knowledge that can control or change the environment for the betterment of the individual, family and the entire community. According to Bransford, Brown and Corking (1999), students develop usable biology knowledge if teachers give repeated feedback on the students' understanding.

Crow (2004) looked at the combination of both hands-on and teaching to be able to stimulate the students' understanding. Several studies globally, nationally and at school level have indicated that most students are not prepared for a world that is shaped by science and technology (Pepsin, 1998). This is shown by the poor performance in examinations by the students. Poor performance especially in biology is global (Valveerde & Landing, 1998; Fonsecca & Conboy, 2006). From Caribbean Examinations Council (CEC) examiners (1987-

2002), students demonstrated a lack of understanding of many of the biological concepts tested hence the poor performance noted in these examinations.

Dina (2013), argues that students' achievement in biology in National Examination for Senior Secondary Certificate Examination (SSCE) was unsatisfactory for quite some years. He attributed this to lack of innovative teaching strategies like the use of the concept attainment model (CAM). In Kenya, there has been a nationwide outcry about the performance of biology by students and also the subsequent drop in the number of students taking biology (Aduda, 2009).

Table 1: Candidates' overall performance in Kenya from2013 - 2017

Year	Maximum Score	Mean score	Mean percentage
2013	200	63.26	32.06
2014	200	63.65	32.57
2015	200	69.59	31.55
2016	200	58.37	35.16
2017	200	37.85	23.45

Source: K.C.S.E annual report 2017

The Kenya National Examination Council (KNEC) report of 2008 indicated poor attainment and misconception of biological concepts in gaseous exchange. KNEC (2017) attributed the poor performance to poor adopting of pedagogical practices by teachers. Further Owino *et al.* (2004), associates the poor performance in biology to inadequate teaching-learning resources, the teaching methods used and parental inability to support education. Kibwezi Sub-County Public Secondary schools' students have had poor performance due to poor attainment of the biological concepts.

Table 2: Summary of Biology students' performance in K.C.S.E in Kibwezi Sub-County from 2014 – 2016

Year	Mean score	Mean percentage score
2014	3.984	26.008
2015	4.200	26.128
2016	4.109	26.098

Source: K.C.S.E report 2016

The report of CAM reflects how students should know how to learn but not what to learn.

1.1 CONCEPT ATTAINMENT MODEL

Concept attainment model searches for and lists attributes that can distinguish exemplars from non-exemplars of the 'Yes' and 'No' of various categories (Bruner, Goodnow & Austin, 1956). It uses positive and negative examples or clues to guide the categorization into significant groups. It involves both decision-making and personalized historical experiences of each student. Joyce and Weil (1967) further looks at concept attainment to focus on decision-making and categorization process that leads to creation and understanding of concepts. Bruner et al. (1956) talks of concept attainment to be able to ensure:

- Concept is attained after minimum encounter has been made on relevant examples
- A concept is attained with certainty regardless of the number of instances one tests.

– Minimum amount of strain on guessing and memorization guarantees attainment of a concept.

Teachers use CAM when they want their students to learn a set of attributes about biological concept, group or category. When using the CAM, the teacher has to have a stack of cards with a picture or word about a new concept to be taught. From these cards, the teacher is expected to tell the students to guess and discuss the common positive characteristics of the sub-topic to teach alongside with the negative characteristics of the same sub-topic. The teacher is expected to hold up the cards of the concept of the topic and allow the students to say "No" if a different picture or pictures of the concept are there. In this study, a constructivist method of study and learning was entirely used to learn gaseous exchange in both plants and animals which has been viewed as difficult (KNEC, 2008 & 2017). Concept attainment model was based on three principles – the principle of conceptual clarity, principle of multiple examples and the principle of conceptual competence (Marzono, Pickering & Pollock, 2001). This study used these principles to prove how CAM improves learning activities that allow proper achievement and increased students' understanding of biological concepts. The study found out that students taught using CAM showed better understanding of biological concepts through better scores than those taught by conventional teaching methods. This agreed with a research done by Kumar and Mathur (2013), in which there was a significant difference between the mean scores of the experimental and the control groups in physics achievement test that was done after intervention with CAM which the researchers used. In this study, the experimental groups scored higher mean scores than the control groups which were not exposed to CAM but taught using conventional teaching methods.

1.2 CONCEPT TEACHING AND LEARNING STYLE USING CAM

Concept learning has to be carefully planned so that the concepts are learned from simple concrete to complex composite ones. Behaviorist instructional designers looks at concept learning to be able to measure learner's classification behavior while the complex concepts to involve discrimination, transfer and problem-solving process which defined concepts(Gagn'e, (1985). Teaching ought to adopt learning style which Merril (2002), perceives the two types of learners: holistic learner who tend to have a problem with under generation and therefore needs to see more divergent examples to promote generalization; a serialistic learner who usually have a problem with over generalization, therefore needs to have more matched examples and non-examples. Both learners need examples and non-examples. Both learners need examples and non-examples which are essential components of a concept instruction strategy by use of the concept attainment model. Concept attainment opens up a learner to a concept formation as they are asked the yes and no-examples of the concept in which they group the examples into conceptual categories. This is followed by testing the initial categories against further examples and non-examples which finally generate a set of critical attributes that defines the concept they are learning. The influence of a concept attainment model as an instructional strategy is further bolstered by the fact that it makes students achieve the skills of identifying similarities and differences so as to generate and test hypothesis about the concept (Marzano, Pickering & Pollock, 2001).

The concept of teaching using CAM follows four steps: Describing the behavior in which before teaching any concept the behavior of the student should be analyzed by the teacher; Providing examples of the concept stage where the teacher presents positive (Yes) examples and negative (No) examples to the students in a sequence that makes beneficial and useful comparison between these examples; Defining the concept stage in which the learner should be able to define or explain the concept with their own examples and words; finally evaluating the knowledge stage done by asking the students questions or examples of the concept.

1.3 STATEMENT OF THE PROBLEM

There has been a National outcry that achievement in sciences biology included is poor (see table 1). This may be due to the level of attainment and understanding of biological concepts which is associated with poor teaching methods. Much of the teaching of biological concepts has been through the use of the packaged information and the teacher is the authority of the information. Other factors associated with the poor achievement are inadequate teaching materials, class size and parental inability to support education. There is little research known by the researchers that have been done on how students would effectively attain biological concepts through learning how to learn but not what to learn and therefore there was a need to research on the effect of concept attainment model to the achievement in biology in public secondary schools and the education for life objective.

1.4 PURPOSE OF THE STUDY

The study was carried out to find out the effect of concept attainment model on learning achievement in biology in public secondary schools in Kibwezi Sub-County, Kenya.

1.5 RESEARCH OBJECTIVE

The objective of this study was to establish the extent to which concept attainment model influences the levels of students' understanding and learning achievement of biological concepts in public secondary schools of Kibwezi Sub-County, Makueni County Kenya.

1.6 CONCEPTUAL FRAMEWORK ON CONCEPT ATTAINMENT MODEL ON LEARNING ACHIEVEMENT IN BIOLOGY

The conceptual framework of this study was based on Bruner's learning theory (Bruner, 1957) and the component display theory (CDT) by Meril (1964). Bruner's theory emphasis on the learner who should be able to learn how to learn with the teachers' role is to create a situation in which learners learn on their own instead of the packaged information. Component display theory focuses on allowing the learner to select and control their own instructional methods that would enable them to attain the three performance levels: Memory and recall, application or utilization and generalization. The framework in Figure 1 shows the dependent variables as the learning achievement in biology particularly on the level of the students' understanding of the biological concepts. The independent variables are the use of the concept attainment model in the teaching of biology instead of conventional methods. The conceptual framework also shows interviewing variables such as teaching

resources, learning environment and students physical, mental status and abilities that impact of learning achievement.

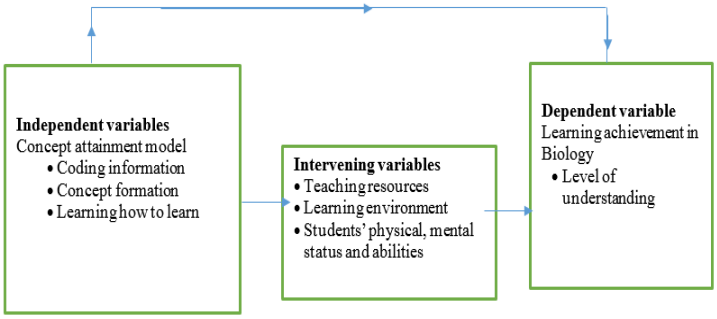

Figure 1: Relationship between Concept Attainment Model and Learning Achievement in Biology

2. RESEARCH METHODOLOGY

This study adopted the quasi-experimental design that involves Non-Equivalent Control Groups. This design was preferred because secondary school authorities do not normally allow their classes to be dismantled and reconstituted for the purpose of study (Shadish, Cork & Campbell, 2002). Prater (1983) states that Non-Equivalent Control Group Design allows collection of participants in a group that cannot or should not be divided up. It helped to assess the effect of the treatment group relative to the control group: the interaction and treatment condition: the effect of the pre-test relative to the post-test and lastly the homogeneity of the groups the treatment was administered (Borg & Gall, 1998). Quasi-Experimental; Non-Equivalent Control Groups Design Controls major threats to internal validity except those due to interaction and history, Maturity, and instrumentation (SEKARAN, 2006). The pre-test and post-test approaches were used to partially eliminate the initial differences between the experimental and control groups.

Table 3: Quasi-Experimental; Non-Equivalent Control Group Design

Group	Pre-test	Intervention	Post-test
T1	B1	RX	A1
C1	B2	O	A2
T2	-	RX	A3
C2	-	O	A4

From the table, C_1 and C_2 represents the sample of the control schools that used the conventional methods; Group T_1 and T_2 represented the sample of experimental schools that received the intervention. B_1 and B_2 represented the pre-tests that was given to T_1 and C_1 before any intervention was given. Rx denotes the treatment or intervention that was given by use of the concept attainment model; while A_1, A_2, A_3 and A_4 indicate the post-test that was given to all the groups involved in the study; "O" represented no treatment given; (-) represented that no pre-test was given to specific groups. The target population was secondary school students of Kibwezi Sub-County which had 65 public Secondary Schools out of which 2 are single sex Extra County, 5

single sex County Schools, 1 Co-Educational County School , 5 single sex Sub-County and 52 Co-educational Sub-County Secondary Schools. The study targeted 4,564 Form Two students from Co-Educational Sub-County Schools that had almost equal sex-ratios. The study used Co-Educational Sub-County Secondary Schools that were the majority and diploma and degree biology teachers with a minimum of two years teaching experiences.

Stratified sampling was used to assign each of the four administrative divisions of Kibwezi Sub-County the four groups to minimize the interaction between the experimental and the control groups. After that, purposive random sampling was used to select one school per division. Each school formed either the experimental or the control groups. From the random samples, two schools became experimental and two control groups. The total number of students for all the samples was 224 form two students.

Table 4: Total sample of participants in the study by experimental and control groups

Class	C_1	T_1	C_2	T_2	Total
Total per class	52	58	56	58	224

2.1 RESEARCH INSTRUMENT

This study used concept attainment test (CAT) to collect the required data. The CAT had items that tested students' knowledge, level of understanding, and comprehension of the biological concepts. It had a maximum score of 100 marks for those students who scored all the items correct and a minimum of 0 in case all the items are scored wrong. Piloting for the instrument was done in Makindu Sub-County which is next to Kibwezi Sub-County that had similar characteristics. Validation was done by the use of two biology trained teachers who had five-year experience and two biology teachers who are Kenya National Examinations Council biology examiner with 5 years marking experience. The CAT had a reliability coefficient of 0.7 established through the K-R-20 method using the split-half technique.

3. RESULTS AND DISCUSSION

Before the study, C1 and T1 sat for the pre-test CAT which enabled the researchers to assess the homogeneity of the groups before treatment was given. The t-test for the pre-test was done as indicated in Table 5.

Table 5: Independent sample t-test scores of CAT based on C_1 and T_1 groups

Not significant at 0.9802 since $p>0.05$ ($\alpha = 0.05$ level)

Variable	Group	N	Mean	S.D	DF	t-critical	P-value
CAT	C_1	52	15.71	7.247	108	-0.02	
	T_1	58	15.67	9.068			0.9802

From the table, there is no significant differences between the means of the pre-test scores of the students in the experimental and control groups. Therefore the two groups had similar characteristics hence suitable for the study.

The students' understanding of biological concepts was assessed by the pre-test and post-test CAT.

Table 6: Difference between post-test mean scores of the control and the treatment groups.

Groups	C_1 and C_2	T_1 and T_2	Total
N	108	116	224
Mean	19.44	25.02	

The means for all the control groups and experimental groups independently were 19.44 and 25.02 respectively with their mean difference (D) of 5.58. This reveals that the groups with the intervention of the CAM had a higher means in the post-test scores compared to those exposed to conventional methods. The above calculation was done by One-Way Analysis of Variance (ANOVA) procedure.

Table 7: Comparison of mean scores and mean gain obtained by students in the CAT

Overall N = 110 experimental	Group T1	Control group C
Pre-test mean	15.67	15.71
Post-test mean	24.45	19.91
Mean gain	8.78	4.00

At the beginning before the interventions, the means of C_1 and T_1 were at the same level hence there was no significant difference between the two groups. After intervention to the T_1 group, the post-test mean for both T_1 and C_1 showed a significant difference in which the experimental group T_1 got a mean gain of 8.78 while the control group taught by conventional methods gave a mean gain of 4.00.

The mean gain by the experimental group taught using the CAM towards the level of students; understanding indicates that the method is more superior to the conventional methods.

Table 8: Comparison of post-test mean scores based on C_1 and T1 Mean differences

Group	N	Mean scores	P-value
C_1	52	19.71	0.036
T_1	58	24.45	

Table 8 shows that the observed p value is less than 0.05 ($p< 0.05$) hence the differences were significant. This means there is a significant difference between the mean scores of C_1 and T_1 in their post-test CAT scores which was attributed to the intervention given through CAM. CAM increased students' levels of understanding of the biological concepts. This agrees with the findings of Shamnad (2005) where the students taught using the concept attainment model showed better understanding of the Arabic language than those exposed to the conventional methods.

4. CONCLUSION

From the study, concept attainment model was found to be superior to the conventional teaching methods in improving students' understanding of biological concepts. It should therefore be adopted in the teaching of biology to improve the rate and levels of understanding of the biology students.

5. RECOMMENDATIONS

It was recommended that the teacher training colleges, teacher educational programs, workshops, seminars and in-service courses should try to incorporate concept attainment model so as to increase the ability of the biology teachers in teaching. Further research could be done on the:

- Perception of teachers towards the use of concept attainment model
- Attitude of educational experts towards models of teaching
- Topics that can effectively be taught using concept attainment model
- Effects of concept attainment model towards difficult areas in biology

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