

Effects of Vee Heuristic Teaching Approach on Achievement of Boys and Girls in Biology in Public Secondary Schools in Kenya

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ABSTRACT

This study determined the effects of Vee Heuristic Teaching Approach on students' achievement Biology based on gender. This study was conducted in public secondary schools in Tharaka Nithi County, Kenya. Solomon Four – Group Non Equivalent Control Group Design was used. Data was collected from 12 schools randomly sampled from within the county. The sample comprised of 396 Form 2 students from four boys, four girls and four co-educational schools. A Biology Achievement Tests were developed and used for data collection. The instruments were pilot-tested in one boy's, one girl's and one co-educational school to ascertain its reliability. A reliability coefficient value of 0.83 was obtained. Hypotheses were tested using ANOVA, ANCOVA and t-test statistics at $\alpha = 0.05$ level of significance. Means were separated using Least Significant Difference (LSD) pair wise post-hoc comparisons. The study found that Vee Heuristics Teaching Approach (VHTA) facilitated students' achievements in biology regardless of gender.

Key words; Vee heuristic, achievements, biology, gender.

INTRODUCTION

The international community all over the world aim at educating millennial qualified enough to serve in the global task force particularly in scientific, industrial and capacity building. To this end, more and more studies are conducted in science education and continuously developing discipline which obtains information on the existence, development, modification and interrelationships of living organisms on earth (Hulya & Punar, 2010). Problems related to reproduction, nourishment, environment, health, diseases, marriage and family relationships, learning and memory can be solved only through biology education (Sucuoglu, 2003).

Biological knowledge plays fundamental role in most aspects of human life; its application in genetic engineering has made a tremendous contribution towards meeting the demand of food security, medicine and control of a variety of diseases (UNESCO, 2013). Despite this significant role, there is a global concern about the performance in biology by high school students especially at physiology and anatomy topics particularly in South East Asia and Sub Saharan Africa.

In Kenya, the Kenya National Examinations Council (KNEC) examinations reports (2013) indicate that the performance of students at the Kenya Certificate of Secondary Education (KCSE) in Biology is poor when compared with other science subject with boys performing better than girls in virtually all topics in biology. Other related studies suggest that the separation of sexes promotes

better educational experience and improves academic success of students. Those in support of single sex classrooms believe that mixed sex classrooms can be destruction from a child's educational achievement (NASSPE, 2013). Wachanga and Mwangi (2004) while investigating the effects of school category on students' performance established that students in single sex schools outshone those in co-educational schools in Nakuru, Kenya.

While investigating the processes that influence gender differences in access to post-secondary institutions, Deborah (1996), found that gender gap in achievements was as a result of a complex and dynamic interplay between societal factors, the school environment and gender role behavior that structural aspect like poor facilities, inadequate teaching and unethical practices were also reflected as symptoms that could contribute to gender gap in achievement.

One of the notable interventions in teaching of sciences is the use of Vee diagrams approaches. This approach emphasizes the structure of and interplay between the theoretical and methodological dimensions of knowledge. It is essentially a pedagogical technique, heuristic where learning occurs through student-directed, constructivist and inquiry-based discoveries (Roehrig, & Edward, 2001). It is ideal for enabling students to understand how events, processes and objects are meaningfully related because its overall purpose is the interplay between what is familiar and what is to be taught in scientific or mathematical explanation (Novak & Alvarez, 2005). Vee heuristic enables the learners to understand the structure of knowledge, and the process of knowledge construction because knowledge is not absolute, but dependent upon concepts, theories and methodologies upon which world is viewed (Roehrig & Edwards, 2001).

While investigating the effects of Vee heuristics and concepts mapping on achievements of students in chemistry in Liceo de Cagayan University in Philippines, Dominic (2012) observed that Vee diagrams help students develop a rich system of concepts and their learning strategies. It was observed that Vee diagrams help students to use concepts to build conceptual interconnections which help the students to formulate explanations about observed changes.

The use of Vee heuristic has been proven to be effective tool in enhancing achievements in chemistry and physics, however there is no research known to the researcher that has been conducted in Kenya to evaluate the effects of VHTA on students achievements based on gender. It is against this background that the present study was designed.

STATEMENT OF THE PROBLEM

Despite the massive allocation of resources to education sector in Kenya, the sector is still faced by challenges which are likely to undermine the achievement of envisioned 2030 development blue print. One of the challenges is gender parity in performance in science subjects among high school students particularly in biology KNEC reports indicates that students are unable to interpret questions, possess poor scientific language and fail to relate biological knowledge to real life leading to low average mean scores. Research findings recommend a shift from conventional methods of teaching biology to metacognitive approaches to reverse on this negative trend.

OBJECTIVE OF THE STUDY

The study sought to investigate how VHTA affected achievements of boys and girls in secondary school biology.

HYPOTHESES

To achieve the study objectives, the following hypothesis were tested at $\alpha= 0.05$ level of significant.

H₀₁: There is no statistical significant difference in achievement scores in biology between boys exposed to Vee Heuristic Teaching Approach and those who are not exposed to it.

H₀₂: There is no statistical significant difference in achievement scores in biology between girls exposed to Vee Heuristic Teaching Approach and those who are not exposed to it.

H₀₃: There is no statistically significant difference in achievement scores in Biology test between boys and girls who are exposed to Vee Heuristic Teaching Approach.

LITERATURE REVIEW

Education psychologists have consistently found that girls are found to have higher standards in the classroom, and evaluate their own performance more critically. Girls also outperform boys in schools, as measured by students' grades in all subjects and in all age group (Paul, Antonio & Robert, 2001). Although girls do better in school (as measured by report card grades) one might imagine that girls would be more self-confident about their academic activities and a higher academic self-esteem. But that is not the case, paradoxically; girls are more likely to be excessively critical in evaluating their own academic performance. Conversely, boys tend to have unrealistically high estimates of their own academic activities accomplishment (Eva, Ellen & Jill, 2002).

While investigation the interest and attitudes of school students towards biology Prokop (2007) found that biology lessons were relatively popular with greatest preference found among students learning zoology. Girls showed significant interest than boys. It was also observed that interest to learn biology decreased with age. Girls assessed biology as more important and less difficult than boys.

A research conducted on women in learning science and mathematics in Britain revealed that factors that alienate and exclude women from science and mathematics classes beyond the compulsory age include comparisons in performance, lack of co-operative learning environment, lack of teachers, enthusiasm in subject while discouraging teaching methods (Isaac, 1996).

While studying the gender influence on learning styles and preferences of medical students, although not significantly different, the female students population tended to be more diverse than the male population encompassing a broader range of sensory modality combinations within their preference profiles. Teachers need to be cognizant of these differences and broaden their range of teaching styles accordingly.

There is growing recognition that there are psychological differences between genders that affect the way that male and female think, communicate and behave. According to UNESCO (2013) there is no great difference between the attainment of boys and girls in the national examinations. In recent years, however, evidence shows that while boys and girls have improved their performance, girls are achieving higher grades than boys. They outperform boys in examination at all levels and in virtually all subjects even those traditionally considered to be male preserves such as physics and mathematics (NASSPE, 2014).

A growing body of research indicates that there are key differences between boys and girls that can affect both learning and attainment. Boys tend to like recognition for what they have achieved, whereas girls tend to get more on appreciation for who they are as person. An increasing number of schools praise boys in a more covert way, (Eva, Ellen & Jill, 2002).

Mondoh (1998) revealed that girls tend to perceive information concretely and process it reflectively. All efforts to include more activity in Biology lessons could be of great advantage since girls understand better by seeing patterns and connections. This could be achieved using scientific problem solving and Vee heuristics based instruction analogies.

Teachers are less likely to attribute boy's failure to lack of motivation than they are girls failure. Girls may take such criticism at heart and think it's a force indicator of their talent in Biology. Risk taking or the willingness of students to take a chance in answering a question they are not sure of may influence gender differences on tests. Research suggests that the format of the tests may produce gender differences. Numerous studies have reported that boys gamble more than girls in choosing answers to questions that they are not sure of and that may be rewarded by higher scores (Ramos and Lambating, 1996).

This study therefore attempted to find out the effects of VHTA on student's achievements in Biology. From existing literature, research studies shows that there is gender differences in achievements in biology .However, there is limited information on gender differences in achievements in biology when learners are taught using VHTA. In an attempt to fill this gap, this study was designed to throw light in this area.

RESEARCH DESIGN

This study involved quasi-experimental research in which the researcher used Solomon's four – group, non –equivalent control group design (Coolican, 1994). This is mainly because secondary school classes once established exist as intact groups and school authorities do not allow such classes to be broken up and re-constituted for research purposes (Borg & Gall, 1986). The non-equivalent groups, pre-test – post-test approach was used to partially eliminate the initial difference between the experimental and control groups.

This design is shown in figure 1.

Group I	(E 1)	O ₁	X	O ₂

Group II	(C 1)	O ₃	-	O ₄

Group III	(E 2)	-	X	O ₅

Group IV	(C 2)	-	-	O ₆

Figure 1: Solomon's four nonequivalent control group design

X is the treatment where students were taught through Vee Heuristic Teaching Approach.

O₁ and O₃ are pretest while O₂, O₄, O₅, O₆ are posttests.

Group I is the experimental group, which received the pretest, the treatment and the posttest

Group II is the control group, which received a pretest followed by the control condition and finally a posttest.

Group III is the group that received X and a post test, it was not be pretested.

Group IV is a group that received pre-test only.

RESEARCH INSTRUMENTS

Biology Achievement Test 1 and Biology Achievement Test 2 were developed by the researcher. BAT1 was used as pretest and had items on the topics gaseous exchange and respiration that had been covered by form 2 students. Its purpose was to establish the entry behavior of the learners before the treatment. BAT 2 was used as post-test. This instrument was used to assess students achievements in topics based on biochemistry in which the attention was confined to three measures; recall, data manipulation and problem solving. The items in BAT1 were reorganized in BAT2 in order to avoid the possibility of learners receiving identical test on two occasions.

RESULTS AND DISCUSSION

The researcher administered a BAT1 pre-test to two groups involved in the study. The aim of the pretest was to ascertain whether or not the students selected to participate in this study had comparable characteristics before intervention. Group 1 and 2 were subjected to a post-test to ascertain homogeneity of the subjects under study. The results are present in Table 1.

Table 1; Independent sample t-test of pre-test scores on BAT1

Variable	Group	Mean	Std. Dev.	t-value	p-value
BAT1	1N = 99	27.90	8.73	0.117	0.112* (ns)
	2N = 103	23.04	6.43		

As shown in Table 1, the pre-test mean score in groups 1 was 27.90 and that of group 2 was 23.04. Further analysis of these results was carried out in order to establish whether the mean scores were statistically different at $\alpha = 0.05$ significance level. Independent sample t-test results analysis reveals that the pre-test mean scores for group 1 and 2 were not statistically significant ($t_{(1,202)} = 0.117$, $p > 0.05$). Analysis of pre-test based on gender was conducted to establish whether boys and girls selected for the study were suitable for the study. The results are presented in Table 2

Table 2: Independent sample t-test of pre-test scores based on Gender

Variable	Gender	Mean	Stdev	t-value	p-value
BAT1	Male N = 105	24.83	9.67	0.39	0.80* (ns)
	Female N = 97	22.70	6.10		

* (ns) = Not significant at 0.05 α level

The results in Table 2 indicate that the male students had a mean score of 24.83 while that of the

female students was 22.70. This indicates that the BAT pre-test mean scores of male were higher than that of female student. A further analysis of these results was necessary in order to establish whether the mean scores were statistically significant at $\alpha = 0.05$ significance level. The Independent sample t-test results show that the BAT pre-test of male and female students were not statistically significant ($t_{(1,200)} = 0.39, p > 0.05$). Therefore suitable for study.

Analysis of posttest was conducted based on gender of the students. Table 3 presents the mean scores of the post-test BAT1 results obtained by boys in the four groups of study.

Table 3; Comparison of Mean scores of boys in experimental and control groups

Group	N	Mean	Stdev	Std. Error
Experimental 1	47	57.27	9.22	1.34
Control 1	50	39.44	11.64	1.64
Experimental 2	52	58.55	6.88	0.95
Control 2	46	42.93	9.52	1.40
Total	195	49.66	12.68	0.90

Table 3 assents that a total of 99 boys were exposed to VHTA while 96 boys were exposed to control conditions. The achievements of boys in experimental group 1 and 3 had a means score of 52.28 and 58.56 with standard deviation of 9.22 and 6.88 respectively. These mean scores were higher than those of boys in control group 2 and 4 which were 39.44 and 42.93 with standard deviation of 11.64 and 9.52 respectively. In order to establish whether the mean scores from the four groups of study were significant, one way ANOVA of the post-test results was conducted as presented in Table 4.

Table4; ANOVA of posttest BAT results of boys who participated in research

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14146.30	3	4715.43	52.80	0.00
Within Groups	17055.35	191	89.29		
Total	31201.66	194			

Table 4 shows that the mean score of boys from the four groups were significant, $F_{(3, 194)} = 52.81, p = 0.00$. Hence hypotheses one is rejected. This shows that VHTA is ideal in teaching in boys' schools. The posttest results for girls who participated in the study were analysed. The mean scores are presented in table 5.

Table 5; Comparison of Mean scores of girls in experimental and control groups

	N	Mean	Stdev	Std. Error
Experimental 1	52	66.26	14.04	1.94
Control 1	53	42.71	10.54	1.44
Experimental 2	48	60.08	10.87	1.56
Control 2	48	38.75	10.69	1.54
Total	201	52.01	16.35	1.15

The data in table 5 shows that 100 girls were exposed to VHTA while 101 girls were in control conditions. The mean score of girls in experimental groups 1 and 3 were 66.27 and 60.08 respectively. These mean scores were higher than those of girls in control groups 1 and 4 which were 42.72 and 38.75 respectively. In order to establish whether the difference in mean scores for girls were significant, one way ANOVA was conducted. The results for the ANOVA of posttest for girls are presented in table 6.

Table 6; ANOVA of posttest BAT results of girls who participated in research

	Sum of Squares	Df	Mean Square	F	p-value
Between Groups	26718.32	3	8906.10	65.52	0.00
Within Groups	26775.65	197	135.91		
Total	53493.98	200			

The results in table 6 Shows that the differences between the groups of study was significant $F_{(3,197)} = 65.53$, $p = 0.00$, therefore rejecting the null hypotheses two. This indicates that girls in experimental groups performed much better than those in control conditions. Since the samples of students involved in this study were drawn from schools with students with different abilities it was necessary to establish the statistical significance of results based on students' gender using the analysis of covariance (ANCOVA) with KCPE as covariate as shown in Table 7.

Table 7: Analysis of Covariance of posttest based on gender

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	15424.18 ^a	2	7712.09	43.41	.000
Intercept	703.63	1	703.63	3.96	.047
Covariate	14878.31	1	14878.31	83.75	.000
Gender	193.02	1	193.02	1.08	.298
Error	69817.3	393	177.6		
Total	1109330.00	396			
Corrected Total	85241.50	395			

a. R Squared = .181 (Adjusted R Squared = .177)

Results in Table 7 shows the Analysis of Covariance of posttest based on gender. ANCOVA reveals that gender has minimal effects on how students learn biology, R square =18.1%. The achievements of boys and girls was not significant $F_{(1,393)} = 1.087$, $p=0.298$. To ascertain whether VHTA had any effects on students' achievements by gender an independent sample t-test was conducted. The results are presented on Table 8.

Table 8: Independent sample t-test of post-test BAT scores of boys and girls exposed to VHTA

Gender	N	Mean	SD	T	Df	p-value
Male	97	57.62	16.35	1.59	195	0.01
Female	100	63.18	12.68			

An examination of the results in the Table 8 shows that VHTA post-test mean score for the boys 57.62 and that of girls 63.18 and quite similar. The independent sample t-test results indicate that the differences in BAT post- test means scores of boys and girls are not statistically significant ($t_{(1,195)} = 1.59$, $p>0.05$). In the light of this, the null hypothesis three which stated that there is no statistically significant gender difference in achievement of boys and girls who are taught through VHTA is accepted. This implies that boys and girls exposed to VHTA performed equally better

The results of study have shown that there are no statistical significant difference between the achievement scores of boys and girls who are exposed to VHTA. They also show that boys and girls taught through VHTA perform significantly better than those taught through conventional teaching approaches. Therefore VHTA is more effective in enhancing students' achievements in biology regardless of their gender than conventional teaching approaches.

In another study Girls were found to outperform boys in schools (as measured by students' grades in all subjects and in all age group, (Paul, Antonio & Robert, 2001). Although girls do better in school (as measured by report card grades, One might imagine that girls would be more self-confident about their academic activities and a higher academic self-esteem. While establishing interest and attitudes of school students towards biology Prokop (2007) found that biology lessons were relatively popular with greatest preference found among students learning zoology. According

to UNESCO (2013) there is no great difference between the attainment of boys and girls in the national examinations. Boys tend to like recognition for what they have achieved, whereas girls tend to get more on appreciation for who they are as person. An increasing number of schools praise boys in a more covert way, (Eva, Ellen and Jill, 2002).

While investigating the processes that influence gender differences in access to post-secondary institutions in Uganda, Deborah (1996), found that gender gap in achievements was as a result of a complex and dynamic interplay between societal factors, the school environment and gender role behavior that structural aspect like poor facilities, inadequate teaching and unethical practices were also reflected as symptoms that could contribute to gender gap in achievement. Research done in Europe (Whyte 1986 & Whyld 1983 as cited by Deborah 1996) found that gender stereotyping of roles and activities in the classroom and the school act to lower the achievements of boys and girls in areas considered appropriate for opposite sex. This confirms the importance of using metacognitive approaches of teaching in classroom such as VHTA, which promotes social processes in class.

CONCLUSIONS

There were reasonable learning gains by boys and girls exposed to VHTA as compared to gains obtained by those not exposed to VHTA treatment. Therefore VHTA facilitates students' learning in biology better than conventional teaching method.

The effects of gender did not show any significant influence on students' achievement in biology when VHTA was used. The analysis of boys and girls achievements in BAT 2 revealed a statistical significant difference. This means VHTA is ideal in teaching students regardless of gender.

RECOMMENDATION

In addition to understanding the philosophy upon which VHTA is based, teachers of biology, school administrators and other stakeholders involved in the implementation of biology curricula need to undertake VHTA as they make a transition from a traditional form of instruction to modern methods of instruction. Teachers need to be recognizant of the differences in boys and girls classrooms and address them via VHTA

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