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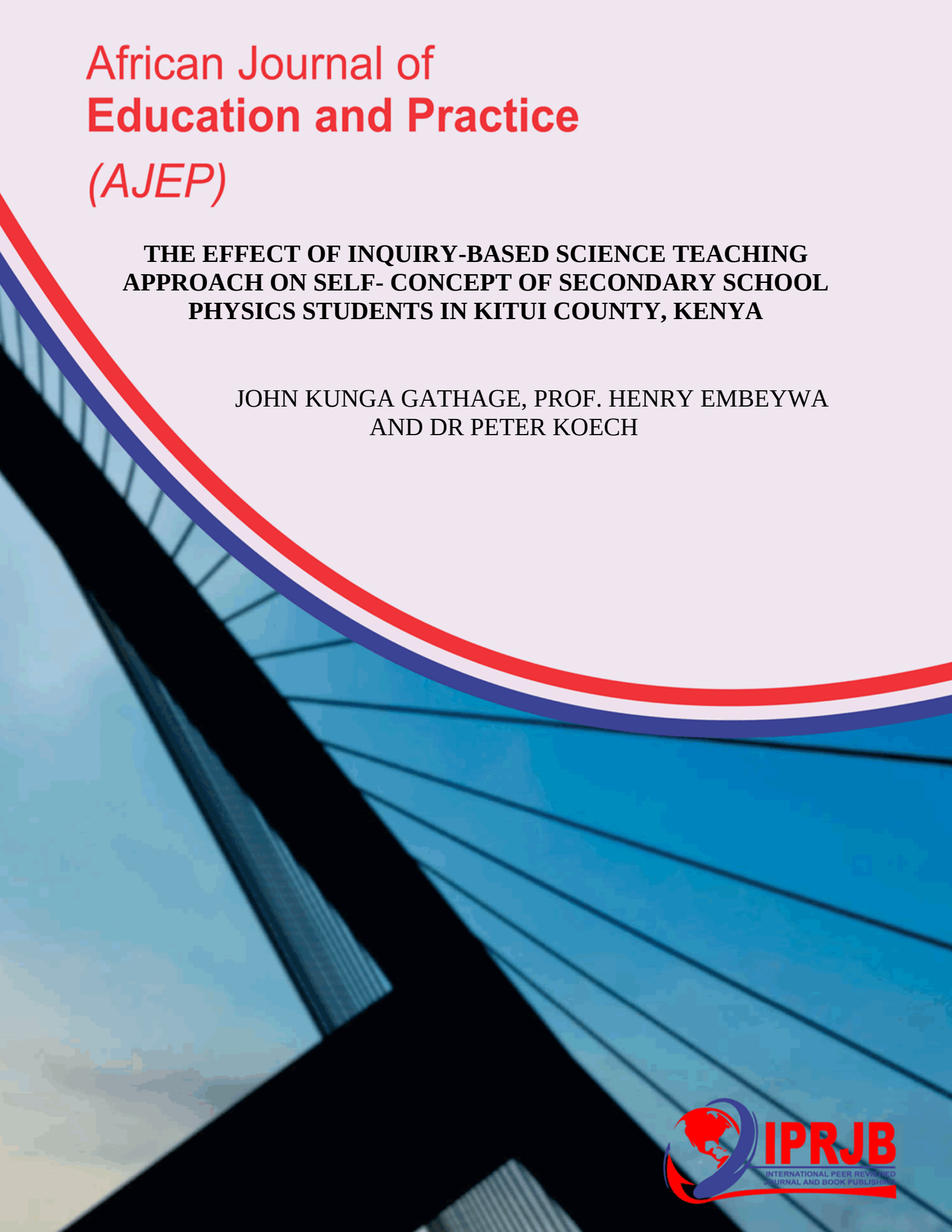
THE EFFECT OF INQUIRY-BASED SCIENCE TEACHING APPROACH ON SELF- CONCEPT OF SECONDARY SCHOOL PHYSICS STUDENTS IN KITUI COUNTY, KENYA

JOHN KUNGA GATHAGE, PROF. HENRY EMBEYWA
AND DR PETER KOECH



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THE EFFECT OF INQUIRY-BASED SCIENCE TEACHING APPROACH ON SELF-CONCEPT OF SECONDARY SCHOOL PHYSICS STUDENTS IN KITUI COUNTY, KENYA

1* John Kunga Gathage
PhD Candidate: School of Education: Machakos University
Corresponding authors email kungajohn81@gmail.com

2* Prof. Henry Embeywa
School of Education: Machakos University: embeywa@gmail.com

3* Dr Peter Koech
School of Education: Machakos University: pkoech2001@gmail.com

Abstract

Purpose: The study sought to investigate the effect of Inquiry-Based Science Teaching Approach on learners' self-concept of secondary school physics students in Kitui County, Kenya.

Methodology: The study adapted Quasi Experimental Research Design and in particular the Solomon's Four Non-Equivalent Control Group Research Design. The target population of the study was 1600 form four Physics students from 40 Extra-County secondary schools in Kitui County. Stratified random sampling was used to select four Extra-County schools (2 Girls and 2 Boys). Purposive sampling was used to select 40 students from each of the four schools and a Physics teacher from each of the two sampled schools; giving a sample size of 160. A students' questionnaire on self- concept was the research instrument. A reliability coefficient of 0.776 was obtained. Both descriptive and inferential data were analysed. The descriptive analysis was by means of frequencies, means, standard deviation and percentages. Inferential analysis was through Analysis of Variance, Chi-square and the Least Significant Difference (LSD) technique at a significance level of coefficient alpha α=0.05.

Findings: The results showed a statistically significant difference in self-concept between students taught using IBSTA and those taught by the conventional methods. The study established that out of the four indicators of self-concept, only role performance was not statistically significant. Consequently, the study concludes that IBSTA is effective in improving students' self-concept.

Unique contribution to theory, practice and policy: The theories were validated in that there was knowledge was actively constructed and need to prepare a learner to have a self -concept after learning. The researcher recommended that creation of an enabling environment for IBSTA be adopted in schools, an appropriate policy should be developed for diploma colleges and universities to train their teacher trainees with an emphasis on IBSTA as part of their Physics training curriculum and KICD should introduce and develop a programme for the Induction and Mentorship of Physics Teachers on the implementation of IBSTA so as to empower them with inquiry skills.

Key words: *Effects, Inquiry–Based Science Teaching Approach, Learning outcome, Self-concept*, physics students.

1.0 INTRODUCTION

Advances in Physics have benefited the transportation industry from building of efficient automobiles, sea vessels, aeroplanes to navigation using the global positioning system (Juan, & Ruez 2009). A study conducted in the USA by Kola (2013), argued that concepts learnt in Physics contribute immensely to the technological infrastructure needed to make scientific advances, discoveries, health education, economic development, energy and environment. In a case, study in Europe by Siddiqui & Khan (2016) argued that physics achievement is positively correlated with the Inquiry-Based Teaching Approach and self-concept because it provides a psychologically safe and encouraging environment. The study is in line with the study by Dupe & Oludipe (2013) which reported that physic achievement is positively correlated with self-concept and methodology used to teaching. The essence of teaching Physics in education field is to bring about positive change in the behaviour, attitude and thinking of a learner (Tebabal & Kahssay, 2011). The Inquiry–Based Teaching Approach is positively associated with outcomes when it incorporates teacher guidance, and negatively when it does not (Aditomo & Klieme, 2019). The approach provides the input of the student with a problem to investigate along with the procedures and materials, (Bulbul, 2010). In Nigeria, Utibeabasi (2011) found out that students with high self-concept achieved more academically than those with low self-concept. According to Mutambuki (2014) Schools that use Inquiry Based learning allow learners to believe in themselves , gain self-concept, and perform better in science practical especially physic than those school that use the conventional methods in teaching. Munuve (2010) reported that most schools in Kitui County perform poorly due to the poor teaching approaches that have been applied by the teachers and the instructional instruments used during the lesson in sciences

Statement of the Problem

Physics achievement is positively correlated with the Inquiry-Based Teaching Approach and self-concept because it provides a psychologically safe and encouraging environment for learning Siddiqui & Khan (2016). However persistent poor performance in KCSE Physics at both the nationally and Kitui County in particular has been greatly attributed by Conventional instructional method (KNEC reports: 2014 to 2019). Several initiatives have been put in place to improve performance in this subject(The Government of Kenya in collaboration with Japanese Government introduced the Strengthening of Mathematics and Science Education (SMASSE) in Secondary Schools. Despite such effort, the performance of learners in K.C.S.E Physics continues to decline. There is currently limited information on the effects of IBSTA on learners' self-concept in physics especially in Kitui County. In an attempt to bridge this gap the current study investigated the effects of Inquiry-Based Science Teaching Approach on the learning outcomes of secondary school physics' students in Kitui County, Kenya.

Research Objective

The objective of the study was to assess the variation in Self-concept between students taught using Inquiry-Based Science Teaching Approach and those taught using the conventional methods in Physics.

Research Hypothesis

The hypothesis was tested at $\alpha = 0.05$ level of significance.

H_{01}: There is no statistically significant difference in self-concept toward Physics between students exposed to Inquiry-Based Science Teaching Approach and those exposed to conventional teaching methods.

2.0. LITERATURE REVIEW

Inquiry-Based Science Teaching Approach is a method that combines the curiosity of students and the scientific method, which enhances the development of scientific creativity while learning, physics (Hesson, & Shad, 2007). Inquiry-Based Teaching Approach provides the input of the student with a problem to investigate along with the procedures and materials (Bulbul, 2010). In their study conducted in Argentina, Sola & Ojo (2007). Observed that inquiry-teaching approach promotes learners' self-concept. Siewett (2011) found that teachers' positive feedback affects achievement of a student and has a big influence on the self-concept of the student. In a study carried out in Europe by Sahrana Vars & Hassan (2012), described science self-concept as the confidence in one's own capability to accomplish scientific tasks through organizing and executing knowledge and skills required to manage a physics content or process. Lau and Chan (2011) reported that students with low or negative self-concept were under-achievers in secondary schools in China. The method used in teaching by the teacher in class can influence learners' self-concept positively or negatively. From this literature, review it clear that in Kenya, Inquiry based science teaching approach has not been investigated widely in Physics except for some effort in Biology, Chemistry and Geography Report (SMASSE 2014). In addition intervention has not greatly impacted on improvement in performance among students of Physics in Kitui County. In the Kenyan context, no study has simultaneously investigated the effects of the Inquiry –Based Science Teaching Approach on self-concept with all its indicators .This study was conducted to address the gap.

Theoretical Review

Constructivist Theory of learning by Dewey's (1938) and Self-Determination theory by Deci and Ryans, 1985 were applied in the study. Constructivism theory states that construct knowledge rather just passively take in information from the environment. The rationale for using this theory was based on the fact that majority of students have difficulty engaging in constructive learning because they fail to make adequate connections that are necessary in arriving at a desired understanding without hypothesizing and questioning as is the practice in physics classrooms currently. By using the constructivism theory, the physics teachers and institution to adapt the IBSTA methods in order to enhance learners, self-concept and this will lead to good learning outcome. Deci and Ryans' on the other hand (Self-Determination Theory) states that people are motivated to grow and change the innate and universal need that is competence, connection and autonomy. Thus there is need to use a IBISTA method of teaching in order for the learner to build self concept which will give a learner drive to be self determined. The theory was relevant to this study as it guided the researcher to describe the complexity of secondary school Physics teaching by investigating the effects of inquiry based teaching approach on secondary school physics students' self-concept as a learning outcome.

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3.0. RESEARCH METHODOLOGY

The study used Mixed Methodology that combines quantitative and qualitative research approaches for the aim of breadth and depth of apprehension and certification.

Research Design

The study applied Quasi-experimental research in which the researcher used Solomon's Four, Non-Equivalent Control Group Design. The design identified a comparison group that was as similar as possible to the treatment group in terms of characteristics. Hence, the method can be said to have caused any difference in outcomes between the treatment and control groups, (Khandker, Shahidur R., et al. 2010).

Table 1: Solomon's Four Non-equivalent Control Group Design (as Adapted from Shuttle worth, 2009)

Group	Design	Group	Pre-test	Treatment	Post-test
I	Experimental	E1	O_1	X	O2
II	Control	C1	O_3	-	O4
III	Experimental	E2	-	X	O5
IV	Control	C2	-	-	O6

Sampling Procedure and Sample Size

Stratified random sampling technique was used to select 2 Extra-County Boys Schools and 2 Extra-County Girls Schools out of the 40 Extra-County Schools in Kitui County. Purposive sampling was employed to select Form Four students taking Physics at KCSE level in each of the selected schools. Simple random sampling was used to assign groups to experimental groups (E_1 & E_2) each with 40 students and control group (C_1 and C_2) with 40 students each. Purposive sampling was used to select a teacher from each of the two sampled schools who taught the control groups using conventional methods.

Research Instruments

The instrument used for this study was a Students' questionnaire on self- concept. The students' self- concept, questionnaire's reliability was recorded as 0.776 and was estimated using the Cronbach's coefficient alpha technique.

Questionnaire for Students (QS)

The students' questionnaire reflected a five Likert Scale where they ticked in the choice box that matched their response on self-concept attributes from the five given responses that included Strongly Agree (SA), Agree (A), Not Sure (NS), Disagree (D), and Strongly Disagree (SD). The instrument had 12 closed ended questions on self-concept adopted from National Foundation for Educational Research of the University of London. The minimum score for each item was 1 and the maximum was 5.

Data Analysis

Both quantitative and qualitative data were generated by the study. Data from the questionnaire was sorted, edited and corded. On qualitative data, the researcher used content analysis approach, which emphasized on thematic analysis. This helped in deriving detailed information from views obtained from the Questionnaire. The data was classified into different themes guided by the research objectives and links between the analyzed data identified and derived from key patterns that emerged. Thereafter, the data was presented in a narrative form, which was reinforced by suitable interpretations. The descriptive analysis used frequencies, percentages, means and standard deviations. Inferential analysis was done using Chi-Squire, Analysis of Variance (ANOVA), and LSD. The hypothesis was tested at alpha value $\alpha = 0.05$ level of significance using the Statistical Package for Social Sciences (SPSS) Version 24 for Windows.

Table 2: Summary of Quantitative Data Analysis Procedure

Hypothesis	Independent Variables	Dependent Variables	descriptive statistics	Inferential Statistics
$H0_2$: There is no statistical significant difference In self-concept towards Physics between student exposed to IBSTA and those exposed to conventional Teaching method in Kitui county Kenya.	IBSTA teaching Approach Conventional teaching method	Learners' self-concept	Frequency Mean Standard deviation percentage	Chi-X^2 ANOVA LSD

4.0 RESEARCH FINDINGS

The guiding objective of the study was to assess the variation in Self-concept between students taught using Inquiry-Based Science Teaching Approach and those taught using the Conventional methods. Data analysis focused on the hypothesis of the study in line with the objective of the study. The hypothesis was examined by the percentage frequencies, Chi-squire technique followed by ANOVA and then LSD. Self-concept consists of four indicators: self-image, Self-identity, Self-esteem and Role- performance

The responses showed that IBSTA enabled students do things on their own which meant that they developed inner confidence in their abilities to learn. They felt that they had what it took to learn and they could do more reading on topics that they did not clearly understand. The inquiry-based science teaching approach cultivated a yearning in the students for the different activities they were engaged in through the inquiry-based approach as they found them engaging and interesting. Such a learning environment encouraged students to think critically, satisfied them and developed their self-concept. The inquiry based science teaching approach further enabled the learners to understand their strengths and weaknesses as well as acquire an internal drive that enhanced their self-concept.

The findings also showed that inquiry-based science teaching approach changed the perception and conception of students towards physics. The approach encompassed methods that were able to engage the students which eventually lead to them enjoying and liking the subject. The approach focused on skills development, attitude, feelings and cognitive abilities. Students who

were taught using the inquiry-based approach had better performance than those taught using conventional methods due to positive self-concept, perceptions, and thoughts that were engaging and intriguing leading to positive thinking.

Self-concept mean score for those students in the experimental groups E1 and E2 (M_1=67. 68, M_2 56.95) were higher than those in the control groups C**1** and C**2** (M_1=43.42, M2=42.13). This means that inquiry based science teaching approach (IBSTA) promoted high mean scores on self-concept.

The four indicators of Self- concept: self- image, self- identity and self- esteem were highly correlated with learner's outcome except for role performance which was not statistically significant since (F=2.145, df=3, Md=1.579 and P=0.097).

Table 3, shows the Chi -Square average mean scores on self-concept based on role-Performance.

Table 3: The Chi -Square Average Mean Score on Self-Concept Based on Role-Performance

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	48.582[a]	8	0.481
Likelihood Ratio	59.737	8	0.000
Linear-by-Linear Association	.030	1	0.863
N of Valid Cases	150		

a. 3 cells (20.0%) have expected count less than 5. The minimum expected count is 3.04.

Source: The Researcher, 2020

The results in table 3 indicate that P=0.481, df=8 and α=0.05. This shows that P> 0.05. These findings imply that there is no significance association between role performance and IBSTA. The findings contradict those of a study by Bati (2014) who argued that the inquiry method stimulates creativity of a learner that gives an internal drive of a learner (self-concept), which enhances good learning outcome.

ANOVA was also computed and the significant differences between these two groups (control and experimental group) reported in table

Table 4: ANOVA of Students' Self-Concept Based on Role Performance

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4.727[a]	3	1.576	2.145	.097
Intercept	572.485	1	572.485	779.350	.000
Sub Category	4.727	3	1.576	2.145	.097

a. R Squared = .042 (Adjusted R Squared = .023) df=3

Source: The Researcher, 2020

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The results in table 4 show that the f-statistic was 2.145, for 3 degree of freedom and a mean difference of 1.579. This yielded a significance level of 0.097 that was more that the set value of α=0.05. This indicates that the differences between the mean values were not statistically significant. The findings contradict those of a study by Dupe and Oludipe (2013), which reported that physics achievement is positively correlated with self-concept and the methodology used in teaching.

To understand the differences between the means on self-concept based on role performance, LSD was conducted. The findings obtained were presented in table 5.

Table 5: LSD of Average Scores on Students' Self-Concept Based on Role Performance

(I)Sub-category	(J) category	Mean Sub-Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
C1	C2	.15	.185	**0.426**	-.22	.510
	E1	.63*	.188	**0.404**	-.70	.040
	E2	.17*	.209	**0.544**	-.57	.251
C2	C1	-.15	.185	**0.426**	-.51	.224
	E1	.85*	.197	**0.269**	-.86	-.091
	E2	.48*	.217	**0.588**	-.74	.127
E1	C1	.63*	.188	**0.404**	-.04	.702
	C2	.85*	.197	**0.269**	.09	.866
	E2	.17	.219	**0.449**	-.27	.602
E2	C1	.17*	.209	**0.545**	-.25	.570
	C2	.48*	.217	**0.588**	-.12	.741
	E1	-.17	.219	**0.499**	-.60	.273

Based on observed means.
The error term is Mean Square (Error) = .735.
***. The mean difference is significant at the 0.05 level.**

Source: The Researcher, 2020

The analysis on table 5, indicates that, the difference between C1 and C2 (p=0.426) and E1 and E2 with (p=0.449) was not statistically significant since P> 0.05. This implies that E1 and E2 groups, C1, and C2 obtained relatively the same scores on self -concept based on role performance. However, the comparison between the mean difference in the groups C1 and E1 (p=0.404), C1 and E2 (p=0.545), C2 and E1 (0.269) and C2 and E2 (0.588). The findings show that the difference between the mean was not statistically significant since P> 0.05. This shows that the experimental groups' mean was less than the control groups' mean in self-concept based on role performance. The above findings contradict a study by Siddiqui and Khan (2016), who argued that physics achievement is positively correlated with the inquiry, based Teaching Approach on self-concept.

The average percentage results on students' response on self-concept was determined and the results of the findings were as indicated in table 6.

Table 6: Overall Percentage Results on Students' Responses on Self –Concept

Average Array	E1	C1	E2	C2
Self-Image	63.51%	39.47%	66.67%	40.17%
Self-Identity	57.64%	42.10%	53.70%	45.45%
Self-Esteem	74.49%	44.74%	54.63%	41.88%
Role Performance	73.48%	47.37%	52.78%	41.03%
Grand Mean	**67.28%**	**43.42%**	**56.95%**	**42.13%**

Source: The Researcher, 2020

Table 6 results indicate that, the respondents from the experimental group had better outcomes to compare to the control group. The average scores for the experimental group were E1 (67.28%) and E2 (56.95%) while the average scores for the Control groups were C1 (43.42%) and C2 (42.13%). The average arrays of experimental groups were higher than that of the control group. This implies that then experimental groups possessed high levels of self-image, self-identity, and self-esteem and role performance than the control groups.

To understand whether there was a statistically significant difference in self-concept and the teaching approach used, the following hypothesis was tested:

H_{02}: There is no statistically significant difference in self-concept toward Physics between students exposed to Inquiry-Based Science teaching Approach and those exposed to Conventional teaching methods.

A chi-square was used to test the hypothesis. Table 7 presents the findings on the t-test computation of the significant differences between mean

Table 7: Overall Results of Chi-square for Self-Concept

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	31.969[a]	8	.000
Likelihood Ratio	40.565	8	.000
Linear-by-Linear Association	.239	1	.625
N of Valid Cases	150		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.70.

Source: The researcher, 2020

From the tabulation on table 7, P=0.0005, df=8 and α=0.000. This shows that there is a significance association between self-concept and IBSTA. Additionally, the percentage that represents the ratio of the actual count to the expected count was not violated because it was not greater than 20%. These results are in line with a study by Kaboro and Githae (2015), which found out that students who were taught using the conventional method had a low self-concept while those who were taught using inquiry method had a significantly high self-concept.

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In order to determine if there was a significant difference in each of the 4 indicators of self-concept, analysis of variance (ANOVA) was conducted and the findings are as recorded in table 8.

Table 8: Overall Results of Analysis of variance (ANOVA) for Self-Concept

ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	110.422	3	36.807	27.605	.0005
Within Groups	194.672	146	1.333		
Total	305.093	149			

Source: The Researcher, 2020

The analysis on table 8 indicates that, the F-statistic was 27.605, for 3 degree of freedom and a mean difference of 36.807. This yielded a significance level of 0.0005 that was less that the set value of $\alpha = 0.05$. This implies that there was a statistically significant difference between the means for self- concept of the two groups under study. The implication of this is that the inquiry-based approach positively influenced self-concept, which in turn had a positive effect on the learning outcome.

To further understand, the statistical difference between the scores obtained, it was essential to find out whether there was any statistically significant difference among the means of the different study groups, LSD was computed and the findings obtained were shown in the table 8

Table 8: LSD Overall Results on Self-Concept after Treatment

(I) Sub-category	(J) Sub-category	Mean Diff. (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
C1	C2	.584*	.263	**.508**	.06	1.10
	E1	8.535*	.267	**.000**	-2.06	-1.01
	E2	11.155*	.269	**.000**	-1.69	-.62
C2	C1	-.584*	.263	**.508**	-1.10	-.06
	E1	8.119*	.265	**.000**	-2.64	-1.60
	E2	8.739*	.267	**.000**	-2.27	-1.21
E1	C1	8.535*	.267	**.000**	1.01	2.06
	C2	8.119*	.265	**.000**	1.60	2.64
	E2	.380	.270	**.162**	-.15	.91
E2	C1	11.155*	.269	**.000**	.62	1.69
	C2	8.739*	.267	**.000**	1.21	2.27
	E1	-.380	.270	**.162**	-.91	.15

*. The mean difference is significant at the 0.05 level.

Source: The Researcher, 2020

The results in table 8, show that the mean difference between C1 and C2 with (p=0.508) and E1 and E2 (p=0.162) was not statistically significant since P> 0.05. This implies that E1 and E2 groups, C1, and C2 obtained relatively the same scores on self-concept. However, the

comparison between the mean difference in the groups C1 and E1 (p=0.000), C1 and E2 (p=0.000), C2 and E1 (0.000) and C2 and E2 (0.000), were statistically significant. Since P< 0.05. This shows that the experimental groups' mean was higher than the control groups' mean on self-concept. Therefore, the null hypothesis two, that stated, *H_{02}: There is no statistically significant difference in self-concept toward Physics between students exposed to Inquiry-Based Learning and those exposed to Conventional teaching methods,* was rejected.

5. 0 CONCLUSION AND RECOMMENDATIONS

Conclusions

From the summary of the findings above, the following conclusions were made:

Inquiry based–science teaching approach significantly influences self-concept as one of the learning outcomes. This is because it enabled students do things on their own which meant that they developed inner confidence in their abilities to learn. They felt that they had what it took to learn and they could do more reading on topics that they did not clearly understand. The inquiry-based science teaching approach cultivated a yearning in the students for the different activities they were engaged in through the inquiry-based approach as they found them engaging and interesting. Such a learning environment encouraged students to think critically, satisfied them and developed their self-concept.

Inquiry based science teaching approach showed no significant influence on role performance as one of the indicators of self –concept in both experimental and control groups.

Recommendation

Recommendation for practice

Physics Teachers should adopt IBSTA since the inquiry-based approach is an interactive model that ensures students are hooked onto the session and focuses on engaging them during the learning process. It also enhances self-concept and consequently leads to better scores in Physics.

School administrators should reward Physics teachers who use IBSTA to create a culture that would improve students' inquiry skills of engagement, elaboration, exploration, explaining and evaluation which consequently improves students' learning outcomes by making them creative, motivated, competent and builds self-concept.

Since online practical lessons can be carried out in science subjects, the school management should expand ICT infrastructure, computer hardware and practical integrating software for schools to conduct experiments online using the IBSTA which will enhance development of learners' self -concept.

Recommendation for policy

KICD to introduce and develop a programme for the Induction and Mentorship of Physics Teachers on the implementation of IBSTA so as to empower them with inquiry skills

Ministry of education in collaboration with other education stake holders to seek for Sources of funding to purchase more science practical equipment and build more infrastructure to promote the use of IBSTA by Science teachers in preparation for the implementation of the Competence-Based Curriculum

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