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INFLUENCE OF TEACHERS' INSTRUCTIONAL STRATEGIES AND STUDENTS' LEARNING STYLES ON ACADEMIC ACHIEVEMENT IN KENYAN HIGH SCHOOL PHYSICS

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Abstract:
This study investigated the influence of Teachers' instructional strategies and students' learning styles on academic achievement in physics among Kenyan high school students. A quasi–experimental pre-test post–test non-equivalent control group design was employed to investigate how three teachers' instructional strategies (guided-inquiry, cooperative learning and direct instruction) and three learning styles (visual, auditory and kinaesthetic) influence academic achievement in Physics practical work while controlling for gender. The target population was all form three Physics students in Navakholo Sub-County area of Kakamega County. A sample size of five hundred and nineteen (519) form three physics students were selected through multistage sampling procedures (purposive sampling, proportionate stratified random sampling and simple random sampling). One null hypothesis was tested at 0.05 level of significance to guide the study. Physics Achievement Tests 1 and 2 (PAT_1 & PAT_2) and Learning Style Questionnaire. Teachers' Instructional Guides on Guided-Inquiry (TIGITS), Cooperative (TIGCTS) and Direct Instructional Strategy(TIGDITS) were used to collect data. Validity and reliability of the instruments were assessed. Analysis of covariance (ANCOVA), Multiple Classification Analysis (MCA) and Scheffe multiple comparison test were used to analyse the data. Findings revealed, a significant effect on the academic achievement of physics students taught with different instructional strategies considering their different learning styles. Recommendations were provided.

Keywords: Instructional practices, learning styles, academic performance, physics practicals

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1. Introduction

Science education in a global and local perspective must foster understanding of concepts among students as a result of their intellectual commitments and practices. Such knowledge of science concepts is necessary in developing students' skills and abilities in preparation for their exposure to the outside world. Skills like critical thinking, problem-solving, and information literacy are tools for life-long learners who in turn contribute to the growth of a nation (Gonzales & Reyes, 2016). The challenge in teaching science is to create experiences that involve the student in his or her own understanding and application of the scientific concepts required to make sense of the experiences in the environment. Secondary Schools attempt to achieve the educational goals through instruction within the school disciplines. Physics education is, therefore, about achieving educational goals through a context of physics (Meheux, 2017).

Physics is taught in secondary education and serves as a preparation for further training and prepares students to be useful citizens within the society. In order to achieve the objectives of physics education at this level of education, the subject should be well presented to students through proper instructional strategies. The teachers' choice and use of suitable instructional strategies for which the acquisition of knowledge, skills or attitudes is paramount. There are various techniques adopted by the teacher in order to make teaching and learning effective and hence affect the students' academic achievement (Akinbobola, 2015). Instructional strategies are a significant determinant of students' academic achievement and process skills acquisition in science and specifically in physics. The selection of proper instructional strategy in a science lesson ensures the achievement of the stated instructional objective effectively. Instructional strategies are used in the presentation of the lesson to help the students learn by ensuring the smooth delivery of the content. It is a process by which an instructional module, instructional phase, or an entire course is delivered. Instructional Strategies employed by teachers in the course of teaching and learning of physics should be interactive and student-centered so as to develop creative and entrepreneurial skills in the individual students. This study focused on three instructional strategies which were; guided inquiry, cooperative learning and direct instructional strategies which are student' centered. Teacher's choice of instructional strategy should be aligned to students' preferred learning styles.

Learning styles research has been applied at an ever increasing rate to the problems of education thus suggesting that learning styles could be extremely important aspects in the move to improve curricula and teaching process in school (Ikitde, 2013). According to Aljaberi (2015), the most frequently preferred learning style shows better performance than other learning styles. The ability to understand students' learning styles can increase educational outcomes. Teachers should take into consideration of these learning styles in their classroom activities. This can help students gain competence in what they learn and improve their academic achievement (Ibrahim & Hussein, 2016). Other studies have shown that most students learn best when the style of presentation is aligned with their preferred learning style. It is

essential for teachers to understand the students' learning styles and also for students to understand their learning styles (Vanessa, 2011; Wilson, 2011). By understanding different learning styles, teachers may gain insights into ways of making academic information more accessible to various groups of learners, and increased awareness of individual learning styles can help educators impart new knowledge in a memorable way (Brady, 2013). Likewise, if students are aware of their preferred learning styles, they will be able to recognize their strengths and weaknesses, and by doing so, they can then develop strategies for active learning.

1.1 Problem Statement

The research evidence available indicates that despite efforts by many schools to improve the performance in science subjects specifically, there is still a poor students' academic achievement among secondary school students globally and at national level where Kenya is not an exception (Alshami, 2013; Konyango et al., 2018; KNEC, 2018). Physics being a science subject constitutes two aspects; the theoretical aspect and the practical aspect. Students' are examined in both aspects at both internal and external examination. In the Kenyan context, Kenya National Examination Council (KNEC) Examiner's Reports (2015, 2016 and 2017) stated that students show deteriorating performances in the Practical Physics at the Kenya Certificate of Secondary Examination (KCSE) level. This in turn would account for their poor performances in theoretical Physics.

It is generally observed that the conventional instructional strategies commonly used in schools do not accommodate the students' preferred learning styles equally. Therefore, one of the most important challenges that science teachers face is to be tolerant and identify learning differences among their students. As a result therefore, there is always a mismatch between the preferred students' learning styles and the instructional strategies used by the teachers. To find solution to these problems, there is need to get a balance of suitable instructional strategies and student's individual learning styles. In the view of these, could there be any observable changes in the students' academic achievement with different learning styles taught using different instructional strategies?

1.2 Purpose of the Study

The purpose of the study was to investigate the influence of teachers' instructional strategies and students' learning styles on academic achievement in Kenyan high school physics. Specifically, the study was designed to examine the achievement of physics students with different learning styles (Visual, Auditory and Kinaesthetic) taught using different instructional strategies (guided inquiry, cooperative learning and direct instruction).

1.3 Research Objective

To investigate the difference in mean academic achievement in physics practicals among students with different leaning styles when taught using different instructional strategies while controlling for gender.

1.4 Research Hypothesis

The following hypothesis was formulated and tested at .05 level of significance.
There is no difference in the mean academic achievement in physics practicals for students with different learning styles when taught using different instructional strategies while controlling for gender.

2. Research Design

Quasi-experimental pretest – posttest non-equivalent control group design was adopted for the study. The population of the study consisted of all the 694 form three physics students in the 24 public secondary schools in Navakholo Sub county area of Kakamega County, Kenya. A total of 519 students took part in the study in their intact classes. Multistage sampling technique was used. It involved; purposive sampling, proportionate stratified random sampling and simple random sampling techniques. Purposive sampling was used to select secondary schools with at least one intact stream of physics students at form three and one trained physics teacher out of 24 schools in Navakholo sub-county. A total of twenty one schools were selected from the 24 schools. After the purposive sampling of schools with at least one intact physics stream, proportionate stratified random sampling was used to select 21schools that were used in the study based on their proportion in each division. Physics Achievement Tests (PAT1), (PAT2) and Learning Styles Questionnaire (LSQ) were the instruments used to gather data for this study. The Questionnaire was a thirty (30)) multiple choice instrument, where a respondent chose from options (a), (b) and (c) which represent preferred learning style (Visual, auditory and Kinaesthetic respectively). The instrument was formulated by Barbe, (1979); the questionnaire was used to determine students' individual learning styles. The PAT1 20 items testing three practical skills questions. It was administered to students as a pre-test and post-test. The PAT_1 was designed to assess students' achievement in the selected physics topics. The time allowed for the test was 2 hours. A marking scheme was prepared and used to score the test. Each tested skill was allocated ten marks giving a maximum possible score of 30 marks and a minimum possible score of 0.The validation of LSQ was ascertained by three psychologists while that of PAT1 and PAT2 was ascertained by three physics educators. The instruments were pilot-tested with 75 students in two schools that was not used for the main study. Test-retest approach was used to establish the reliability of LSQ and the results obtained were subjected to Pearson Product Moment Correlation. The result showed that LSQ has a reliability coefficient of 0.84. The results obtained from PAT1 were also subjected to test-retest approach and the result showed a reliability coefficient of 0.81.

Teacher quality variables were controlled by using research assistants who were the physics teachers in each school to teach each group. Training on the use of the instructional strategies was conducted for the research assistants in one week. A pre-test was administered to both the experimental and control groups and the results were used as covariate measures in order to take care of possible initial differences in groups. After the pretest, the subjects were taught the concept of current electricity for four weeks. The experimental group 1 was taught using guided inquiry, experimental group 2 was taught using cooperative learning while the control group was taught using the direct instructional strategy. A post-test was administered to all the groups at the end of the treatment period. LSQ was also administered to the students and the results were used to classified students into their respective learning styles. The data collected were analyzed using descriptive statistics, analysis of covariance ANCOVA, multiple classification analysis MCA and Scheffe's post hoc test. All the hypotheses were tested at .05 level of significance.

3. Results

Table 1: Descriptive statistics of Means and Standard Deviations for the Academic Achievement Pre-test and Post-test

Academic Achievement Test						
Teachers' Instructional Strategies	**Student's Learning Styles**	**Pre-test**		**Post-test**		**Number of students**
		Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	
Direct Instruction	Visual	33.21	10.43	56.66	16.17	83
	Auditory	32.50	10.62	58.28	16.12	59
	Kinaesthetic	34.35	8.67	55.54	15.53	55
	Total	33.28	10.03	56.67	15.90	177
Cooperative Learning	Visual	31.74	9.27	65.12	16.19	73
	Auditory	31.38	8.00	61.03	19.72	59
	Kinaesthetic	34.02	7.99	61.09	16.12	54
	Total	32.21	8.40	62.65	17.40	186
Guided-Inquiry	Visual	31.98	11.65	57.74	17.99	59
	Auditory	30.16	9.46	65.00	17.60	37
	Kinaesthetic	31.28	9.16	74.65	14.25	60
	Total	31.15	10.09	65.96	17.92	156
Total	Visual	31.23	9.38	59.83	17.06	215
	Auditory	31.56	9.27	61.32	18.08	135
	Kinaesthetic	32.62	10.64	64.10	17.25	169
	Total	31.86	9.85	61.61	17.45	519

The analysis in Table 1 show the results of the means and standard deviation of the students' academic achievement in the pre-test (PAT1) before treatment and post-test(PAT2) after treatment. The results of the pre-test show the students' learning styles and the teachers' instructional strategies as well as their respective mean scores, standard deviations and the number of students in each category. On average scale the

visual learners had a mean score of (*M*=31.23, *SD*=9.38), Auditory learners had (*M*=31.56, *SD*=9.27) and Kinaesthetic learners had (*M*=32.62, *SD*=10.64) respectively. The results also show the mean scores for the instructional strategies as follows; Direct Instruction (*M*=33.28, *SD*=10.03) Cooperative learning (*M*=32.21, *SD*=8.40) and Guided-Inquiry (*M*=31.15, *SD*=10.09)

These mean scores for the instructional strategies and learning styles are homogeneous and therefore it indicates that before treatment all learners of different learning styles were at the same level.

The results of the post-test show the mean scores and standard deviations of students' learning styles and the teachers' instructional strategies. On average scale the visual learners had a mean score of (*M*=59.83, *SD*=17.06), Auditory learners had (*M*=61.32, *SD*=18.08) and Kinaesthetic learners had (*M*=64.10, *SD*=17.25) respectively. These mean scores were significantly different and it implied that after treatment all learners of different learning styles were not homogeneous. The Kinaesthetic learners had a higher academic achievement mean compared to Auditory and visual learners. The results of the teachers' instructional strategies indicate that the learners instructed by Guided-Inquiry achieved more at a mean score of (*M*=65.96, *SD*=17.92) while those instructed by Direct Instruction and Cooperative learning had means of (*M*=56.67, *SD*=15.90) and (*M*=62.65, *SD*=17.40) respectively. Similarly these mean scores were significantly different and it suggests that after treatment all learners of different learning styles had different levels of academic achievement in the post-test after instruction by different strategies.

From the findings it was observed that the students of Kinaesthetic learning style had a higher academic achievement (*M*=64.10, *SD*=17.25) compared to those of visual and Auditory learning styles. On the other hand, students instructed by guided inquiry (*M*=65.96, *SD*=17.92) achieved more than cooperative and direct instructional strategies.
To determine whether the observed differences in academic achievement by treatment groups across the different learning styles were statistically significant, inferential statistics were conducted.

3.1 Hypothesis One

There is no significant difference in the achievement of physics students with different learning styles when taught using different instructional strategy while controlling for gender. To test this hypothesis, ANCOVA was computed and the results are presented in Table 2.

Table 2: Results of Analysis of Covariance (ANCOVA) with Academic Achievement as DV and Instructional Strategies as IV and Gender as Covariate

Dependent Variable: Academic Achievement Post-Test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	26752.377[a]	17	1573.669	6.017	.000	. 170
Intercept	154542.480	1	154542.480	590.879	.000	.541
Main Effect						
Instructstr	8897.232	2	4448.616	17.009	.000	.064
Learnst	63.094	2	31.547	.121	.886	.000
Gender	1102.377	1	1102.377	4.215	.041	.008
2-way Interactions						
Instructstr * Gender	5084.048	2	2542.024	9.719	.000	.037
Learnst * Gender	167.095	2	83.548	.319	.727	.001
Instructstr * Learnst	728.312	4	182.078	.696	.595	.006
3-way Interactions						
Instructstr * Learnst * Gender	1179.255	4	294.814	1.127	.343	.009
Error	131035.003	501	261.547			
Total	2127854.000	519				
Corrected Total	157787.380	518				

a. R Squared = .170 (Adjusted R Squared = .141)

The result revealed no significant interaction effect in the three way interaction between the learning styles, instructional strategies and gender for both experimental and control groups ($F_{(4,501)}$=1.13,P=.34). The two way interaction between the teachers' instructional strategies and gender was statistically significant ($F_{(4,501)}$=1.13, p=.000). The predicted main effects of instruction strategies ($F_{(4,501)}$=1.13, p=.000) and gender ($F_{(4,501)}$=1.13, p=.041) were statistically significant.

Based on the obtained P-value, the decision was to reject the null hypothesis which stated that there is no significant difference in academic achievement in physics practicals among students with different leaning styles taught using different instructional strategies while controlling for gender. This therefore shows that teachers' instructional strategies and students' gender had a positive influence the students' academic achievement in physics practical work. On the other hand the results also show that the students learning style did not have a statistically significant influence on the students' academic achievement in physics practical work. The result also implied that both the experimental groups and control groups were statistically different in their academic achievement after treatment as influenced by instructional strategies.

From the findings, it was concluded that instructional strategies (guided-inquiry, cooperative Learning and Direct instruction) influence students' academic achievement in physics practical work based on gender. Consequent upon the existence of significant difference in the academic achievement by students of different learning styles instructed by different instructional strategies, a Multiple Classification Analysis (MCA) was considered to determine the magnitude of the influence of the independent variables (learning styles and instructional strategies) as shown in Table 3.

Table 3: Multiple Classification Analysis (MCA) of the Post-test Achievement Scores

Grand mean=60.8285							
Variable			**N**	**Unadjusted Devn'**	**Eta2**	**Adjusted for Independent+Covariate**	**Beta β**
Academic Achievement Post-Test	Student's Learning Styles	Visual	215	-1.77823	.105	-1.43326	.091
		Auditory	135	-.28486		-.51645	
		Kinaesthetic	169	2.48980		2.23123	
	Teachers' Instructional Strategies	Direct Instruction	177	-4.93847	.218	-4.84758	.212
		Cooperative learning	186	1.04512		1.12218	
		Guided-Inquiry	156	4.35716		4.16216	
Multiple R^2			.236				
Multiple R			.056				

Table 3 shows results of Multiple Classification Analysis (MCA)of academic achievement of students of different learning styles used to determine the magnitude of achievement means scores. The results show that learning styles (Visual, Auditory and Kinaesthetic) have an index relationship of 0.105 (Beta value of 0.091) with the academic achievement in physics practical work. The results also indicates that the deviation from the grand mean of 60.82 of the adjusted post-test scores of students of visual learning style is -1.43, while the deviation of the adjusted post-test scores of students of Auditory learning styles -0.52and the adjusted post-test scores of students Kinaesthetic learning style is 2.23. This implies that students of Kinaesthetic learning style had more positive academic achievement than students Visual and Auditory learning styles. The multiple regression index R of 0.056 and multiple regression squared index (R^2) of 0.236, implied that 23.6% of the variance in the students' academic achievement was attributable to the influence of the students' learning styles (Visual, Auditory and Kinaesthetic).

Results of the Multiple Classification Analysis (MCA), as presented in Table 4.3, were also used to determine the magnitude of the mean achievement scores of students exposed to the different treatment conditions. The results show that instructional strategies (Guided-Inquiry, Cooperative learning and Direct instruction) have an index relationship of 0.218 (Beta value of 0.212) with the academic achievement in physics practical work. Table 4.5 also indicates that the deviation from the grand mean of 60.82 of the adjusted post-test scores of students taught using the Guided-inquiry instructional strategy is 4.16 while the deviation of the adjusted post-test scores of students taught using Cooperative learning instructional strategy is1.12 and the adjusted post-test scores of students taught using Direct instruction strategy is -4.84. This implies that students taught using the Guided-Inquiry strategy had more positive academic achievement than students taught using the Cooperative learning and Direct instructional strategies. The multiple regression index R of 0.056 and multiple regression squared index (R^2) of 0.236, implies that 23.6% of the variance in the students' academic achievement was attributable to the influence of instructional strategies (Guided-Inquiry, Cooperative learning and Direct instructional strategies).

Based on the finding of the multiple classification analysis MCA, it was concluded that both independent variables (learning styles and instructional strategies) had an influence on students' academic achievement at the level of learning styles (R^2=.24, β=.091) and instructional strategies (R^2=.24, β=.21) respectively. Therefore instructional strategies had a more positive influence.

Following the existence of significant difference in the academic achievement by students of different learning styles instructed by different strategies, a Scheffe's post hoc test for multiple comparison was conducted to determine where the difference occurred in academic achievement as shown in Table 4

Table 4: Result of Scheffe's Post Hoc Test for Multiple Comparison of Teaching Strategies on Students' Achievement in Physics Practicals

(I) Teachers' Instructional Strategies	(J) Teachers' Instructional Strategies	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Direct Instruction	Cooperative Learning	-5.9836*	1.74508	.003	-10.2677	-1.6995
	Guided-Inquiry	-9.2956*	1.82506	.000	-13.7761	-4.8152
Cooperative Learning	Direct Instruction	5.9836*	1.74508	.003	1.6995	10.2677
	Guided-Inquiry	-3.3120	1.80426	.187	-7.7414	1.1173
Guided-Inquiry	Direct Instruction	9.2956*	1.82506	.000	4.8152	13.7761
	Cooperative Learning	3.3120	1.80426	.187	-1.1173	7.7414

Based on observed means.
The error term is Mean Square (Error) = 276.191.
*. The mean difference is significant at the 0.05 level.

Table 4 shows that the mean difference between guided inquiry and Direct Instruction was 9.29, between cooperative learning and guided-inquiry was 3.31, and between direct instruction and Cooperative learning was 5.98. The results therefore indicate that a comparison of students exposed to guided inquiry and Direct Instruction then Direct instruction and Cooperative learning had a significant difference in their students' academic achievement. On the other hand cooperative learning and Guided-inquiry had no significant effect on the students' academic achievement. This means that the three groups differ in their mean scores on achievement in physics practical work.

From the findings it was therefore concluded that inquiry based instructional strategies such as (guided inquiry and cooperative learning) strongly enhance the students' academic achievement in physics practical work in Navakholo sub-county, Kakamega County. It is therefore important for teachers of physics to impress the use of inquiry based methods of instruction when teaching physics practical work unlike conventional methods of teaching.

4. Discussion of Findings

The result of hypothesis one (H01) as shown in Table 2 indicated that a significant difference was found to exist in the academic achievement of students of different

learning style (Kinaesthetic, Auditory and Visual) in physics practicals work after being exposed to different instructional strategies (Guide-inquiry, Cooperative learning and Direct instruction). As a result therefore the hypothesis which stated that there is no significant difference in academic achievement in physics practicals among students with different leaning styles taught using different instructional strategies while controlling for gender was rejected. Multiple Classification Analysis (MCA) as shown in Table 4.3 indicated that 60.82 % of the total variance in the achievement of students in physics is attributed to the influence of teaching approaches after being exposed to treatment. The Scheffe's post hoc analysis as shown in Table 4.4 indicated that instructional strategies (Guide-inquiry, Cooperative learning and direct instruction) had a significant difference in their students' academic achievement. The result showed that direct instruction method of instruction had a lower students' achievement in Physics practical work after being exposed to post-test. This was followed by Cooperative learning while guided-inquiry was seen to be the most effective. The result also indicated based on gender girls performed better than boys in physics practical work. These results concur with those of Akinbobola & Olufunminiyi (2015) whose results showed that guided discovery was the most effective in facilitating students' transfer of knowledge in physics. This was followed by demonstration while expository was found to be the least effective. The results are also in agreement with those of Mina (2017) which revealed that there was significant difference in the mean academic achievement of students who were taught physics using concept mapped instructional strategy and those taught to using expository method. The results also agree with those of Barasua, Nwanekezi & Chetta (2018) who reported that students exposed to collaborative learning strategy had improved academic achievement scores than those in the individualistic or demonstration strategy groups comparatively.

5. Conclusion

The results of descriptive statistics showed that the teachers instructional strategies attained mean scores (Guided-Inquiry achieved (M=65.96, SD=17.92), Direct Instruction (M=56.67, SD=15.90) and Cooperative learning (M=62.65, SD=17.40) against the maximum of M=100% on students' academic achievement. The ANCOVA statistics revealed a significant interaction between instructional strategies and gender ($F_{(4,501)}$=1.13, p=.000) at α=.05. These results implied that there was significant influence of teachers' instructional strategies on students' academic achievement in physics practical work. The results of the multiple classification analysis test revealed that both independent variables (learning styles and instructional strategies) had an influence on students' academic achievement at the level of learning styles(R^2=.24, β=.091) and instructional strategies(R^2=.24, β=.21) respectively. The Scheffe's Post-Hoc test revealed the direction of the difference in the students' achievement in physics practical work was due to Direct Instruction strategy. Results of intervening effect of gender on teachers instruction strategies and students learning styles it showed that girls performed better than boys in the physics practical work as reflected by the academic

achievement mean scores of (M=65.41, SD=17.33) and (M=60.31, SD=17.32) respectively. Therefore based on the results of this study it was concluded that teachers' instructional strategies influence students' academic achievement among physics students in practical work in Navakholo sub-county.

5.1 Recommendations

Based on the findings of this study, the following recommendations are made:

1) Teachers of physics should employ instructional strategies that are investigative for effective teaching.
2) Teachers of physics should identify the learning styles of their students and use appropriate instructional strategies that will correlate with the learning styles for effective teaching and learning to take place in physics classrooms.
3) Curriculum planners for high school physics should design the physics curriculum in such a way that will benefit students with different learning styles.

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