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A Case Study of Secondary Schools in Kenya: Is Physics Achievement an Interplay of Attitudes and Strategy?

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Abstract:

Secondary school students' achievement in Physics has been declining despite the pivotal role played by industrial development. Declining performance has been linked to various factors. The different strategies used in teaching Physics coupled with learners' attitudes have been reported to affect students' achievement in Physics. Based in Nyeri County, the study assessed the interplay between collaboration and attitude on secondary school students' achievement in Physics. The Solomon Four group quasi-experimental design was used. A sample of 173 form-four students in mixed-day secondary schools in Nyeri County participated in the study. The sample was obtained through purposive sampling to obtain a list of mixed-day secondary schools that offer the Physics subject at form four. Through random sampling, a list of four schools that participated in the study was obtained. The schools were randomly assigned to experimental and control groups. The research instruments consisted of the Physics Pre-test (PPT), the Physics Achievement Test (PAT) and the Students Attitude Questionnaire (SAQ). Kuder Richardson test was used to determine the reliability of the PPT and PAT. A reliability coefficient of 0.7 and 0.8 was obtained for the PPT and PAT, respectively. Cronbach alpha coefficient of 0.875 was obtained for the SAQ after the piloting of the instruments. Descriptive statistics (mean, standard deviation) and inferential statistics (t-test and ANOVA) were used in data analysis. The Statistical Package for Social Sciences (SPSS) version 22.0 was used for all statistical analyses. The hypothesis was tested at $\alpha=0.05$ level of significance. The findings from the study showed that students had a positive attitude towards Physics and that the students' attitude towards Physics did not affect their achievement in Physics. The findings demystified the belief that the general attitude of students towards physics is negative. The study also revealed that the collaborative teaching strategy improved the students' achievement in physics for both HA and LA towards physics learners. The study recommended that teachers should expose students to Collaborative Strategy more frequently and teacher training programs to equip teachers with skills for collaboration. The findings of the current study are helpful to the curriculum developers in revising the curriculum towards learner-centredness by cooperating in collaborative activities towards achieving the purpose of the Competence Curriculum. Curriculum designing bodies may find the information useful during the in-servicing of teachers towards making the curriculum more learner-centred. Instructional material developers may find the information useful while developing materials that enhance learner activity, which will enhance positive attitudes towards physics and other subjects, especially in the science field. The findings of the study may be useful in curriculum reviews towards competency-based curriculum at the secondary school level through in-cooperation of collaborative tasks since collaboration is one of the core competencies to be achieved through the curriculum.

Keywords: Achievement, collaborative teaching strategy, attitude

1. Introduction

Attitudes are defined as favorable or unfavorable responses to things, places, people, events or ideas (Koh & Kogawa, 1995). A learner's attitude towards a given area of study plays a crucial role in teaching and learning concepts in that area. A negative attitude towards a certain subject makes learning that subject difficult, while a positive attitude stimulates students' effort and leads to high achievement in the particular subject (Velloo, Nor & Khalid, 2015; Solpuk, 2017; Attah, Ita & Nchor, 2018); Magdona & Rita, (2017) and Astaline, Kurnigwan, Nugroho & Lika, (2019). In Africa, a study carried out in Ruanda by Godwin and Okoronka (2015) revealed a strong relationship between students' attitude and their corresponding academic achievement in Physics, which was in agreement with Serkan (2017); Velloo *et al.* (2015); Akinbobola, (2009); Alimen, (2009); Mekonnen, (2014) studies in which the declining Physics academic achievement was associated with students' negative attitude. According to the Centre for Mathematics, Science and Technology (2012), Stephen (2010) and Orleans (2007), the perceptions by many students that Physics is a boring and hard subject have resulted in the low student achievement in Physics witnessed in African countries. For instance, in Nigeria, Ruanda, Tanzania and Kenya, students' results in Physics at secondary school for the last half-decade have indicated low achievement grades and declining numbers of students opting to study Physics (CEMASTE A (2015), WAEC (2014), Ruanda Education Board (REB) (2015), National Examinations Council of Tanzania (NECTA) (2019) and KNEC (2020)).

Teaching strategies used in a particular subject influence the students' attitudes towards the subject (Fulmer, Ma & Liang, 2019; Juuti, Lavonen, Uitto, Bymah & Meisalo, 2010; Osborne, Simon & Collins, 2010). For instance, Fulmer *et al.*

(2019), in a descriptive survey study on 1334 Chinese middle school students in Physics and Chemistry classrooms, established that attitudes towards science were positively related to cooperative teaching strategies like group work in class or developing small group projects. In addition, Fulmer *et al.* (2019) established that there was no effect of constructivist-oriented instruction or direct instruction on students' attitudes towards science, contradicting Juuti *et al.* (2010) and Osborne *et al.* (2003) that demonstrated the potential for constructivist inquiry-oriented teaching to increase students' attitudes towards science among middle school science students in Finland.

Scholars have attempted to explore the use of collaborative strategies and their effect on students' attitudes toward science. For instance, a study was done in Turkey by Orphan and Ruhan (2007) on 50 7th-grade students in science. The first objective of the study was to determine the effect of collaborative problem-based learning in science education on students' attitudes experimentally using the pre-test and post-test techniques. The findings of the study revealed that the problem-based collaborative learning model positively affected students' attitudes. The second objective was to establish the effect of collaborative problem-based learning in science education on students' achievement based on attitudes. The findings of the study indicated that the model (collaborative problem-based learning) enhanced students' achievement towards science for both students with negative and positive attitudes. Further, the model improved the students' conceptual development and kept their misconceptions at the lowest level. In Veloo, Perumal, and Vikneswary's (2013) study in Malaysia, a qualitative approach was used in which questionnaires were administered to 149 students in rural primary schools. The study aimed to seek the relationship between collaborative inquiries-based instruction (CIBI) on students' attitudes towards science and teachers' support towards science achievement. Analysis done through linear regression revealed that the three independent variables significantly influenced science achievement. The CIBI influenced the students' attitudes as well as achievement. Further, the study revealed that the CIBI made students socialize more, resulting in a more conducive learning environment, which made learners derive more joy in learning, agreeing with Broggy and George (2008).

Unlike the studies by Orphan and Ruhan (2007) and Veloo and Vikneswary (2013), the study by Broggy and George (2008) in Ireland was done on undergraduate students over a longer study period (2 academic years). The concept mapping technique was used as a tool of collaboration. The study involved 84 participants studying Physics education. The study was done in two phases (1 and 2). Phase one was done in the first academic year, in which students were taught concepts of light and sound, after which the first questionnaire (Q1) was administered. The second phase was done in the second academic year in which the students were taught Electricity and Magnetism, after which the second questionnaire (Q2) was administered. The questionnaires Q1 and Q2 consisted of both open-ended and close-ended questions. An analysis of both questionnaires revealed that students' attitudes towards Physics improved after working with and experiencing Concept Maps collaboratively. Most students in the class agreed that collaborative concept mapping was a beneficial tool in the classroom as it boosted learners' willingness to participate.

A case study on teaching Physics through collaborative experimentation at Vilnius University in Europe by Christopher, Rita and Jamie (2010) revealed that students exposed to collaborative experimentation achieved more than those who were not exposed to it. The study further revealed that collaborative experimentation enhanced the development of positive attitudes towards Physics in higher education, partially contradicting Taqi and Al-Nouh (2014), in which collaborative group experimentation in Physics did not improve students' academic achievement in secondary schools in Australia and Newzealand but greatly improved the student's attitude in Physics as both NA and PA students reported that they enjoyed the tasks and desired to work in collaborative groups more and more. A study by Taraban, Roman, Cathy, Myers, Russell, Polland, Robin and Bowen (2007) on the effects of active learning experiences on achievement, attitudes and behaviours in high school Biology on 408 students in Texas compared collaborative laboratory-based activities and traditional instruction outcomes. In the study, a questionnaire responded to by the teachers who used active learning revealed that students' behaviors changed and students' active practises also increased, implying that collaborative learning changed the way students respond towards Physics activities.

Karenauskaitė and Jucevičienė (2005) identified six criteria that affect attitudes towards science learning. Among them were: openness in communicating, openness for innovation and skills of learning in partnership (collaborative learning). When these skills were used, they improved students' attitudes towards Physics for both NA and PA students. Studies by McGowan (2008) in America, Tao (2001) in China, and Naki (2009) in Turkey that employed the six criteria concur with Karenauskaitė and Jucevičienė (2005) by indicating that students who were taught by implementing group problem-solving strategies in Physics were more willing to try solving problems. The students enjoyed doing Physics and were eager to rise to solving challenging problems. In the three studies discussed, students were more willing to exercise problem-solving in collaborative groups than as individuals. While in groups, they continued trying until they found answers. Such students, over a long time, developed both positive attitudes towards the subject of physics and enhanced achievement. Zakaria, Chin and Daudi (2013) and Qaisar, Dilshard and Hussein (2015) conducted studies in Malaysia and Pakistan, respectively, on the effect of collaborative group work on students' attitudes towards Mathematics. Both studies were qualitative, whereby questionnaires and interviews were used. The findings indicated that collaborative group work had a positive effect on students' attitudes towards Mathematics as well as achievement, favoring the low-attitude students. Telina, Alamina and Temitope (2013) and Adesoji (2008) undertook studies on the influence of collaborative teaching on secondary school students' attitudes towards Physics in Nigeria in which they observed improvement in girls' attitudes towards physics when they were exposed to collaborative teaching through group laboratory experiments agreeing with Shibley and Zimmaro (2002) on students' attitudes towards Chemistry. These findings point to the increasing attitude toward science as a requirement for enhanced achievement in science subjects.

The guided discovery and think-pair-share collaborative activities used in Chemistry instruction improved students' attitudes towards Chemistry in Nigeria, as discussed by Adekunie (2015) and supported by Mwangi, Nyagah, and Mugambi (2020) in Kenya. In the study conducted by Adekunie (2015), a pre-test, post-test control group quasi-experimental design with a 3x3x2 factorial matrix was adopted. The sample consisted of 242 SS1 students in intact classes from 6 secondary schools who were randomly assigned to the experiment and control groups. Students in the experimental groups performed better than those in the control group. In a study by Ardodo and Gbore (2012), 30 junior secondary school students in Nigeria participated in a quasi-experimental research. The aim of the study was to predict the attitudes and interests of science students of different abilities on their academic performance in basic science. A Multiple regression analysis was done, which revealed that science interest possessed the highest strength for predicting achievement than attitude among the students in their different ability level groups. The recommendation from the study was that teachers should use innovative methods that will stimulate students' interest in an attempt to make learning science more meaningful to the learners and thereby generate improved learning outcomes that will lead to a change in attitude towards science.

Concerning studying Physics through students' collaborations in Physics, Changeiywo (2011) found students exposed to collaborative learning by using mastery learning in Nyeri county of Kenya to develop a positive attitude towards learning Physics than those who were not exposed to it. The result in Changeiywo (2011) agreed with Kipkemboi, Mukwa and Too (2019) in Mathematics and Githae (2015) in Biology, who reported increased excitement among selected secondary schools in Kenya and Nakuru County, respectively, but disagreed with Barchok (2011) in Bomet County of Kenya. In Kipkemboi *et al.* (2019), Githae (2015), and Barchok (2011), the experimental groups were exposed to a collaborative concept mapping strategy, and Solomon's four-group design was used. Therefore, the choice of a teaching technique may positively or negatively influence learners' attitudes towards Physics.

2. Statement of the Problem

Performance in Physics in mixed secondary schools is influenced by a variety of factors, including learner characteristics such as attitudes and abilities and teaching/learning strategies. In Kenya, students' achievement in Physics in the last two decades has been generally low, on average, with 4.1 out of the mean score (KNEC, 2020). Several studies have been conducted to address declining learner achievement (Nderitu, 2007; Kuria, 2014; Murithi, 2018). These studies have pointed to the general students' negative attitude towards physics and the effectiveness of teaching strategies as major areas of concern. There is, hence, a need to examine the strengths and weaknesses of the efficiency levels of the teaching strategies. Studies worldwide have indicated that the application of collaborative teaching strategy enhances learner involvement, creativity and overall achievement, especially in Physics. Although a variety of studies on the application of the collaborative teaching strategy have been conducted worldwide and across various disciplines, investigations into its effectiveness have been scanty. In addition, it has been observed that even related studies on the effectiveness of Collaborative Teaching Strategy in Physics have mainly focused on single-gender schools, whereas mixed school contexts have not been assessed accordingly. As a result, there is little data on how effective the application of the Collaborative Teaching Strategy is in mixed-school scenarios. This is the Lacuna in Knowledge that the study sought to address. To redress this gap, the study was designed to assess the extent to which the use of the Collaborative Teaching Strategy is effective in influencing learners' attitudes and achievements in Physics in mixed secondary schools in Nyeri County, Kenya.

3. Hypothesis

The hypothesis of the study was:

H₀₁: There is no statistically significant difference in attitude change towards Physics between learners exposed to Collaborative Teaching Strategy and those who are exposed to Conventional Teaching Strategy in Nyeri County, Kenya

4. Methodology

Before commencing with the experiment, the experimental group E1 and control group C1 were exposed to pre-testing (PPT) to determine their entry abilities and all the groups (E1, C1, E2 and C2) were exposed to the student's attitudes questionnaire to determine their attitude levels. The content on cathode rays was divided into logical portions and taught during the timetabled period of three weeks. Collaborative activities such as discussions, peer teaching and thinking pairs were incorporated into the teaching of the lesson content for the experimental groups. A post-test was administered to all groups. Groups E1 and C1 were exposed to pre-tests and post-tests, while groups E2 and C2 were exposed to post-tests only. The students' attitude questionnaire was administered to all the groups (E1, C1, E2 and C2) at the end of teaching. The SAQ consisted of students' biodata and 33 items based on students' views and opinions on collaborative learning. The attitudes questionnaire consisted of items in five sections indicated by A, B, C and D. Section A included 9 items on whether learners derive joy in learning Physics, section contained 6 items on students' feelings about the nature of Physics, section C consisted of 11 items on students' appreciation for the Physics content and section D included 7 items on students' future prospects in Physics. A pre-test (PPT) was administered to E1 and C1 before the onset of experimentation. The results of the pre-test were used to establish any initial differences among the groups by carrying out an independent samples t-test. The students were guided on how to respond to the questionnaire, after which the attitude questionnaire was administered to all four groups before and after the experiment. E1 and E2 were taught using the Collaborative Teaching Strategy. All the teachers of Physics in the form four classes in the schools selected taught using

the same implementation schedule for a period of three weeks. Post-tests were administered to all groups at the end of the topic. The researcher then marked the PAT for all the groups to allow for uniformity in the marking.

5. Results and Discussions

5.1. Collaborative Teaching Strategy, Attitude and Learner Achievement in Physics

The objective of the study was to examine the effect of the Collaborative Teaching Strategy on the achievement of students in Physics based on their attitudes. Students' attitudes were assessed based on data obtained from the questionnaire administered at the beginning of the study before intervention and at the end of the intervention phase. The students were categorized into two groups, namely negative attitude (NA) students and (PA) students, after the first administration of the questionnaire (pre-test). In the analysis, the minimum score on attitudes had a total rating of 34, while the maximum was 119. This gave a range of 85. The students who scored between 34 and $(34+85/2)$ 76 were categorized as having negative attitudes, while those who scored between 76 and 119 were categorized as having positive attitudes (Cohen, Manion and Morrison, 2011). To determine the effect of collaborative teaching strategy on students' attitudes, a comparison of students' scores in the pre-test and post-test on the same instrument (SMQ) was done.

5.2. Descriptive Findings on the Effect of Collaborative Teaching Strategy on Negative Attitude and Positive Attitude Students

The data obtained from students' scores in the students' questionnaire during the pre-test phase was summarized as shown in table 1. The highest positive response was from students who indicated that they were sure that there was a need for them to continue studying Physics, as indicated by a mean of 4.496. A high percentage of learners (85%) reported that Physics gives them opportunities for career choices, as indicated by a mean of 4.444, and 85 % of students agreed that they expect to be able to apply Physics concepts in life situations. Additionally, 73.1% of respondents agreed that they aspire to study a Physics course after KCSE, while 79.4% agreed that they always look forward to Physics activities, as represented by a mean of 4.131, and 81.9% found learning Physics fun, as indicated by a mean of 4.117.

Based on the statements on which learners scored more than a mean of 4.1, it could be interpreted to mean that learners have a positive attitude towards Physics. Since 21 out of 25 statements were rated highly by a mean of more than 3. A notable 21.9% indicated that physics lessons are not involved, while 65% disagreed that they do not feel relaxed during physics lessons, indicating that they do not hate the subject of physics. The distribution of students in the categories is given in table 1.

		Groups				Total
		C1	E1	C2	E2	
Categorized Pre-test Student Attitude	NA	7	2	4	1	14
	PA	29	37	29	44	139
Total		36	39	33	45	153

Table 1: Pre-Test Students Attitude

All the students (153) responded to the attitude questionnaire. In the categorized pre-test students' attitudes, there were more PA students than NA students. The experimental groups (E1 and E2) consisted of only 3 NA students and 81 PA students, while control groups C1 and C2 consisted of 11 NA students and 58 PA students. An independent samples t-test was performed on the students' pre-test scores on the SAQ. The results are indicated in table 2.

	Group	N	Mean Difference	Df	T	Sig	F	Std. Error
Equal variances assumed	C	33	-7.65	73	2.058	0.554	0.353	3.72
	E	45	-7.65					3.73

Table 2: Independent Samples t-test

The independent samples t-test did not reveal any significant difference in means for the two groups as indicated by $F(1, 73) = 0.353$, $P = 0.554$ and $t(-2.058)$, $p = .554$, which qualified the groups as homogenous and suitable for comparison. Students' scores on the elements of attitude at the end of the intervention stage were determined to assess the effect of collaborative teaching strategy on students' attitudes.

The data obtained on students' attitudes after intervention resulted in a mean of 3.79 on a scale of 5 with a standard deviation of 0.490, up from a mean of 3.77 and a standard deviation of 0.558. Students scored a mean of 4 and above on 13-item statements compared to 11 items of the pre-test. The highest positive response was from students who indicated that they expected to be able to apply Physics concepts in life situations, as indicated by a mean of 4.359 and 86.2 % of students agreeing. A notable 89.9% of students expressed that they always look forward to Physics activities, as indicated by a mean of 4.176, up from 4.104 in the pre-test, while 81.3% of respondents agreed that learning Physics is fun, as indicated by a mean of 4.150, up from 4.117. Additionally, 75.7% of students agreed that they aspire to study physics after KSCE, as indicated by a mean of 4.105, up from 73.1% of respondents in students' pre-test attitudes. Respondents' mean scores rose marginally, indicating a slight improvement in students' attitudes towards Physics after the intervention.

5.3. Hypothesis Testing on Effect of Collaborative Strategy on Students' Attitudes

The hypothesis of the study sought to establish whether there is a significant difference between the achievement of students with negative and positive attitudes exposed to the Collaborative Teaching Strategy. Also, it intended to establish whether collaborative teaching strategy had any effects on students' attitudes towards Physics. To establish whether the Collaborative Teaching Strategy had a significant effect on the achievement of PA and NA students differently, a two-way analysis of variance test of the students' pre-test attitude score on their post-test PAT in cathode rays was done. The results are shown in table 3.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	η^2
Corrected Model	5641.917 ^a	7	805.988	4.619	.000	.182
Intercept	64627.628	1	64627.628	370.336	.000	.719
Group	2706.220	3	902.073	5.169	.002	.097
CatPosttestAtt	99.864	1	99.864	.572	.451	.004
Group * CatPosttestAtt	310.199	3	103.400	.593	.621	.012
Error	25304.083	145	174.511			
Total	194214.000	153				
Corrected Total	30946.000	152				

R Squared = .182 (Adjusted R Squared = .143)

Table 3: Two-way ANOVA between Strategy and Achievement Based Students' Attitude

As a model, the effect of the Collaborative Teaching Strategy on groups was significant, indicating the main effect for groups. The effect size is medium (Cohen, 1992). The model, which was significant, was found to account for 18.2 % of the total variance in achievement of students with different attitudes. The differences in achievement between students with positive attitudes and negative attitudes were not significant $F(1,153) = .572$, $P = 0.451$, $\eta^2 = 0.04$. Significant differences were not found between the achievement of students in different groups (experimental and control groups), $F(3,153) = 5.169$, $P = 0.02$. The data obtained did not reveal any significant differences between the achievement of NA and PA students $F(3,153) = .593$, $P = 0.621$, $\eta^2 = 0.12$.

No significant difference in achievement existed between students with positive attitudes (33.243) and those with negative attitudes (30.728). However, significant differences were observed between achievement levels of students in the experimental group E1 ($M = 40.331$) and control group C1 ($M = 27.919$). There were also significant differences in achievement of students in E2 ($M = 36.218$) and those in C2 ($M = 23.475$). Pairwise comparison showed that test scores for students in E1 were significantly different from those of C1 and C2. Univariate test results were also indicative of a significant difference in achievement for test groups $F(1,153) = .572$, $P = .451$ but insignificant for attitude. Students' post-test attitudes were categorized as shown in table 4 and yielded the post Hoc result as indicated in table 5.

Groups	Categorized Students' Test Attitude	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
C1	NA	23.938	3.303	17.410	30.465
	PA	31.900	2.954	26.062	37.738
E1	NA	41.500	9.341	23.038	59.962
	PA	39.162	2.172	34.870	43.455
C2	NA	21.143	4.993	11.274	31.011
	PA	25.808	2.591	20.687	30.928
E2	NA	36.333	5.393	25.674	46.993
	PA	36.103	2.115	31.922	40.283

Table 4: Categorized Students' Post-Test Achievement Based on Attitudes

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
C1	E1	-10.921*	3.0532	.003	-18.856	-2.985
	C2	3.543	3.1837	.682	-4.732	11.818
	E2	-7.772*	2.9539	.046	-15.450	-.095
E1	C1	10.921*	3.0532	.003	2.985	18.856
	C2	14.464*	3.1246	.000	6.343	22.585
	E2	3.149	2.8901	.697	-4.363	10.660
C2	C1	-3.543	3.1837	.682	-11.818	4.732
	E1	-14.464*	3.1246	.000	-22.585	-6.343
	E2	-11.315*	3.0276	.002	-19.184	-3.446
E2	C1	7.772*	2.9539	.046	.095	15.450
	E1	-3.149	2.8901	.697	-10.660	4.363
	C2	11.315*	3.0276	.002	3.446	19.184

Table 5: Multiple Comparisons for the Effect of Attitude on Students' Achievement

The post-Hoc Tukey's (HSD) showed that the achievement of students with a negative attitude from E1 (M=41.500) was significantly different from that of their counterparts from C1 (M=23.938) and those from E2 (M=36.33) were significantly different from those in C2 (M=21.143) with the achievement of students in both experimental groups being significantly higher than their counterparts from the control groups. A similar observation was made on students with positive attitudes, where PA students from E1 obtained a higher mean (M=39.162), which was significantly different from that of C1 (M=31.900). The positive attitude students from E2 obtained higher mean achievement (M=36.103), which was significantly different from that of C2 (M=25.808). The results imply that students exposed to collaborative teaching strategies performed significantly better than those exposed to conventional strategies based on attitude. The results failed to retain the hypothesis that there is no significant difference in achievement in Physics between students exposed to collaborative teaching strategy and those exposed to conventional methods based on attitude. The study also sought to assess whether the use of a collaborative teaching strategy in teaching physics affected the attitudes of students with positive and negative attitudes differently. A one-way analysis of variance in students' attitude change was done. The result is displayed in table 6.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.649	3	.216	1.049	.373
Within Groups	30.757	149	.206		
Total	31.406	152			

Table 6: A One-Way ANOVA Strategy and Achievement Based on Attitude

The differences in attitude change were statistically insignificant at $F(3,152)=1.049$, $P=0.373$. This result supported the retainment of the null hypothesis H_{01} that there is no statistically significant difference in achievement between students exposed to collaborative teaching techniques and those exposed to conventional teaching strategies based on attitude. A post-Hoc test was done on the results of attitude change yielded results that were summarized as shown in table 7.

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
C1	E1	-.11778	.10501	.677	-.3906	.1551
	C2	.05071	.10950	.967	-.2338	.3352
	E2	.02978	.10159	.991	-.2342	.2937
E1	C1	.11778	.10501	.677	-.1551	.3906
	C2	.16848	.10746	.400	-.1107	.4477
	E2	.14756	.09940	.449	-.1107	.4058
C2	C1	-.05071	.10950	.967	-.3352	.2338
	E1	-.16848	.10746	.400	-.4477	.1107
	E2	-.02093	.10413	.997	-.2915	.2496
E2	C1	-.02978	.10159	.991	-.2937	.2342
	E1	-.14756	.09940	.449	-.4058	.1107
	C2	.02093	.10413	.997	-.2496	.2915

Table 7: Post-Hoc Test (Tukey HSD) on Strategy and Attitude Change

The Tukey (HSD) revealed insignificant differences, as indicated by the absence of an asterisk supporting the retention of hypothesis H_{01} that there is no statistically significant difference between the achievement of students exposed to collaborative teaching strategy and those exposed to conventional strategies based on attitude.

5.4. Discussion of Findings on Interaction between Teaching Strategies, Attitude and Student Achievement in Physics

The study aimed to establish whether a collaborative teaching strategy affects students with PA and NA towards physics differently. The pre-test scores on attitude showed that students generally had a positive attitude towards Physics, as implied by a mean of above 3 on most of the items (21 out of 25), resulting in a mean of 3.77 out of a maximum of 5. The observation in the current study is in line with Astaline *et al.* (2019), Serkan (2017), Veloo *et al.* (2015), Quiser, Dilshad and Hussein (2015), Kingir and Aydemir (2012), Chang and Chieng (2008). However, the observation conflicts with Salta and Tzougraki (2004) and Eryilmaz and Fakioglu (2007), who observed neutrality in students' attitudes towards Physics. Godwin and Okoronka (2015), Mekonnen (2014), Centre for Mathematics Science and Technology (2012 and 2010), Stephen (2010), Alimen (2009), Orleans (2007), Akinbobola (2007) and Jimoyiannis and Komis (2001) that reported very high negative attitude of secondary school students towards Physics contradict the finding in the current study. The studies attributed the low enrolments and performance in Physics to the negative attitude among students towards Physics.

Descriptively, the post-test results for students' attitudes showed slightly higher scores compared to the pre-test. The post-test students' attitude mean score increased to 3.79 from 3.77 in the pre-test. The deviations in the experimental groups were higher than for the control groups, concurring with Mathew, Bakhe and Igharo (2013) and Sola and Ojo (2007), who found collaborative guided discovery methods to enhance students' attitudes towards science. The findings in the current study complement Adamu (2012) and Chekour (2017), who found a significant change in the attitude of students towards Biology when they were exposed to collaborative strategy. In Chekour's (2017) exploration, the use of collaboration through computer-assisted instruction in teaching physics made students more interested, excited, satisfied and more willing to participate than those in the control groups, agreeing with Changeiywo (2011), Keraro (2007) and Oloo (2016) who reported increased positive attitude among learners who were exposed to collaborative teaching strategy in Physics and Mathematics respectively. Oloo (2016) also found that students taught through collaborations felt that Mathematics became easy when taught and discussed among peers. In the process of teaching and learning, peer teachers also reinforce their own learning by instructing others. However, the result contradicts Pinar and Filiz (2010), who reported insignificant differences in attitude between students exposed to collaborative strategy through peer teaching and those not exposed to it in science.

A two-way ANOVA did not show significant differences between achievement of students with negative attitudes and those with positive attitudes contradicting Muraina (2019), Veloo *et al.* (2015), Sabiru (2014), Taqi and Al-Nouh (2014), Arodo and Gbore (2012), Juuti *et al.* (2010), Naki (2009) and Osborne *et al.* (2001) who reported that students with negative attitudes were more eager to learn after they were taught using the collaborative teaching strategy than those with positive attitude. Thus, collaborative strategies enhanced students' attitudes towards physics among the NA students more than the students with positive attitudes. Arodo and Gbore (2012) further explained that interactive methods stimulate students' interest and make learning more interesting, thus leading to a change in attitude. The findings of the current study also contradict Roman *et al.* (2007) and Ogunyebi (2018), who reported that active learning changed the way students responded to physics activities, where change implied a change of attitude or behaviour.

6. Conclusion

The objective of the study was to determine whether there is a difference in students' attitudes towards physics between students exposed to the Collaborative Teaching Strategy in Nyeri County, Kenya. The investigation revealed that collaborative teaching slightly affected the achievement of students with different attitudes differently, and neither did it change the attitudes of negative and positive attitudes of students differently. The null hypothesis that there is no statistically significant difference in students' achievement in Physics between students exposed to the Collaborative Teaching Strategy and those exposed to Conventional Teaching Strategy based on attitude in Nyeri County was retained. The study, therefore, concluded that the collaborative strategy, when used in physics instruction, does not affect the achievement of negative attitude and positive attitude students differently. However, the study noted a slight improvement in students' attitudes towards physics among the positive and negative attitude students.

7. References

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