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BRIDGING MATHEMATICAL GAPS IN PHYSICS: THE ROLE OF CHANGE OF SUBJECT FORMULA IN STUDENT ACHIEVEMENT AND ATTITUDE

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Abstract: The knowledge of change of subject formula is indispensable in the study of Physics. Owing to the poor problem-solving skills of secondary school science students leading to their negative attitude towards Physics as a hard subject, gave birth to this study. The study sought to determine the impact of the knowledge of change of subject formula on attitude and problemsolving skills of senior secondary school one (SSS1) Physics students in Rivers State. Quasiexperimental research design was adopted using pre-test and post-test treatment and control groups. Random sampling technique was used to select 150 Senior Secondary one (SSSI) students from Community Secondary School (C.S.S.) Omoku. 76 males and 74 females made up the sample. Physics Achievement Test (PAT) and Attitude of Students towards Learning of Physics (ASTLP) were used to measure student's problem-solving skills and attitude. The reliability of the instrument returned a reliability coefficient of 0.99 using Kuder-Richardson's Formula-21. Four research questions and five hypotheses guided the study. Data was analyzed using mean, standard deviation, column chart, t-test, and person's correlation. Findings revealed that there is a statistically significant change in attitude and problem-solving skills of secondary school physics students taught change of subject formula. Similarly, in the case of gender, there was a significant change in attitude and problem-solving skills of males and females in the treatment group. Furthermore, the study also revealed that there is no relationship between attitude and problem-solving skills of Physics students taught change of subject formula. Hence, it was recommended that change of subject formula should be included as one of the topics to be taught in Senior Secondary One (SSS1) Physics curriculum in Nigeria.

Keywords: Attitude, Problem Solving Skills, Change of Subject Formula, knowledge.

Background of the study

It is generally imputed by secondary school science students that Physics, the study of matter in relation to energy is difficult and challenging among other science subjects (Chemistry and Biology). In Nigeria, secondary school

Physics is divided into three different themes namely, conservation of energy, energy quantization and duality of matter, and Physics in technology (NERDC, 2008). These themes cover the following areas, mechanics, heat (thermal energy), optics, waves, and current electricity. These are pre-requisite knowledge needed by the secondary school science student to advance into the tertiary institution, where they can study engineering, medicine, space science etc. No wonder, a nation cannot grow above its technological knowledge which the study of Physics provides (Alebiosku & Michael, 2011). The study of Physics has stepped into the 21st century, which necessitate the Physics students to possess an assortment of problem-solving skills (Hughes, 2016). But this is not so, as can be seen by the low enrolment of Physics students in our tertiary institutions (Osiah et al, 2021). One of the leading reasons pinpointed as the chief contributor to the low enrolment of Physics students in our higher institutions of learning is the "attitude" of the students who say that Physics is a difficult subject. Mwangi et al (2013) reported that the enrolment of female science students in our tertiary institution is generally very poor as compared to their counterpart. The males have increase interest for Physics while the female tend towards Biology. Obviously, this difference in the number of male and female in the study of Physics could likely be the difference in attitude which has caused a gender gap in the academic achievement as well as the problem-solving skills of Physics students. This attitude has raised a substantial concern amongst educators and in particular, Physics educators (Utusan, 2009). Attitude can be described as a belief, feeling or way of thinking that is implanted in a person, which affects the behavior of the person. Attitude can be positive (favorable) or negative (bias) (Soomro et al, 2011). In this study, attitude refers to the positive or negative feelings of secondary school science students towards the learning of Physics. Positive learning attitudes are significant in the study of Physics as it gives the students the momentum to strive for better academic achievement in their Physics classes. On the other hand, negative attitude retards the academic achievement of the Physics student (Veloo & Khalid, 2015). Most secondary school science students tend to have negative attitude towards Physics due to the formulas they have to recall and transpose as well as the calculations they need to perform and the graphic representations they need to understand and interpret (Saleh, 2014). The lack of adequate knowledge of change of subject formula forms the major hindrance in the difficulties faced by the Physics students in solving Physics problem (Fadaei & Mora, 2015). Due to this defective knowledge, students now have a hard time understanding most topics requiring manipulation of formulas. The theory aspect of these topics may be understood, but they fail in application of Physics laws and principles to problem solving. In Physics, a problem refers to a question to which one does not instantly understand how to come by the answer. Whereas problem solving is a process of identification of the existing problem, determining the physical quantities present in the problem, deciding the best formula(s) with which to solve the problem, and finally utilizing it to solve the problem (Martaningsih et al, 2022). One of the major goals of learning Physics is to produce problem solvers, who can affect their world with the new knowledge gained (Walsh et al, 2007). The study of Physics should not only be to memorize laws and formulae and then solve problems based on what have memorized, because it leads students to act without understanding the reason for solving the problem (Nasibov & Kacar, 2005). Becoming a good Physics problem solver is challenging as it demands critical thinking, adequate understanding of Physics concepts, theories, laws, principles and above all competence in manipulation of formulas and equations (Hegde & Mecra, 2012). In recent studies, it has been found that most Physics students fail in their problem solving because they carry out problem solving by rote memorization of formulas and equations without possessing adequate knowledge necessary to make connection and construct meaning to the problem statement with diagrams to bring the problem to a concrete level where it

is seen clearly (Hegde & Mecra, 2012). On the other hand, an expert utilizes Physics concepts he knows to solve problems, which may require him combining multiple/separate Physics principles, laws, equations, and formulas based on previous knowledge of solving many Physics problems. An expert follows the following approach stated below. i. Focus on the problem: an expert begins by creating a vivid mental image of the problem to be solved by sketching a useful diagram. He goes further to determine the Physics laws, principles and approaches he might apply to solve the problem. ii. Describe the Physics: an expert specifies the coordinate systems consistent with the chosen approach. He further identifies the physical quantities present in the problem as well as the target physical quantity that will surely provide the solution to the problem.

iii. Plan a solution: here, the expert derives a mathematical equation suitable for the problem to be solved and containing all the physical quantities so identified in which he can begin from the known physical quantities to the unknown (the target physical quantity).

iv. Execute the plan: the expert carries out the algebra/calculus (calculation) using the right formula so derived, taking note of correct units of the physical quantities found in the formula before substituting numerical values in place of physical quantities to get the solution for the problem.

v. Evaluate the answer: the expert checks if the solution so gotten is reasonable and complete. If it is what is obtainable in the real world. From the above approach, it can be seen the difference between a novice and an expert. A novice will always encounter difficulty in deriving the appropriate mathematical equation for a given problem because of lack of knowledge of change of subject formula. A formula is a short algebraic expression, showing the relationship between quantities. It is a flexible tool used to calculated one quantity connected with other quantities. (Isik et al, 2005). A formula is also described by Turkish Language Association (2017) as a set of symbols that draws out a general law or principle. Whereas changing the subject of a formula refers to a technique of reordering a formula to get a quantity in terms of other quantities. The process is the same as that of solving an equation. For instance, acceleration is given by the formula; = $\frac{v-u}{t}$, where 'a' is acceleration, 'v' is final velocity, 'u' is initial velocity and 't' is time taken. Any of the quantities can be transposed to become the subject formula. The above formula can be reordered to give $v = u + at$, i.e. making final velocity the subject formula. The knowledge of change of subject formula provides the basis for manipulation of physical quantities, leading to improved problem-solving skills and better attitude towards Physics. When physics students strive to obtain high scores and fail in their Physics class works and examinations, they are quick to attribute it to the difficult nature of the subject, leading to negative attitude towards Physics. Meanwhile, they do not possess the right tool (knowledge of change of subject formula) to attain high scores in their Physics classes. Therefore, if Physics students are given the tool (knowledge of change of subject formula) to improve their problemsolving skills, which will lead them to achieve higher in their Physics classes and in turn lead to improved positive attitude towards Physics. This is what this study seeks to achieve.

Statement of the problem

Physics is a subject that deals with a lot of formulae and equations necessary for problem solving. The knowledge of change of subject formula is crucial to problem solving in Physics. Thus, it has been observed by the researcher that Physics students do not wholly succeed in Physics problem solving due to lack of knowledge of change of subject formula which makes it difficult for them to manipulate and transpose formulae and arrive at the solution of the problem. This lack of knowledge has negatively affected the attitude of Physics students towards Physics and has led to poor academic performance and poor enrolment in our tertiary institutions. Therefore, the researcher

seeks to determine the impact of the knowledge of change of subject formula on attitude and problem-solving skills of senior secondary school one (SSS1) Physics students in Rivers State.

Purpose of the study

The main purpose of this study is to investigate the impact of knowledge of change of subject formula on attitude and problem-solving skills of senior secondary school one (SSS1) Physics students in Rivers State. This study therefore seeks to achieve the following objectives.

i. Determine the difference in attitude of Physics students taught change of subject formula and those taught without.

ii. Find out the difference in attitude of male and female Physics students taught change of subject formula.

iii. Ascertain the difference in the mean problem-solving score of Physics students taught change of subject formula and those taught without. iv. Investigate the difference in the mean problem-solving score of male and female Physics students taught change of subject formula.

Research questions

The following research questions piloted the study.

i. What is the difference in attitude of Physics students taught change of subject formula and those taught without?

ii. What is the difference in attitude of male and female Physics students taught change of subject formula?

iii. What is the difference in the mean problem-solving score of Physics students taught change of subject formula and those taught without?

iv. What is the difference in the mean problem-solving score of male and female Physics students taught change of subject formula?

Hypotheses

The following null hypotheses were put forward to steer the study.

$H0_1$. There is no significant difference between the attitude of Physics students taught change of subject formula and those taught without.

$H0_2$. There is no significant difference between the attitude of male and female Physics students taught change of subject formula.

$H0_3$. There is no significant difference in the mean problem-solving score of Physics students taught change of subject formula and those taught without.

$H0_4$. There is no significant difference in the mean problem-solving score of male and female Physics students taught change of subject formula.

$H0_5$. There is no relationship between attitude and problem-solving skills of Physics students taught change of subject formula.

Theoretical Framework (Cognitive Dissonance Theory)

Cognitive dissonance theory was first investigated by Leon Festinger in 1957. Festinger cognitive dissonance theory centers on a situation involving clash or inconsistency in attitude and beliefs. This inconsistency gives rise to feelings of cognitive discomfort leading and producing a change in one of the attitude and belief, aimed at minimizing the discomfort and restoring cognitive balance.

The cognitive dissonance theory has been studied over years in different situations, in other to promote the fundamental idea. On that ground, factors that are important in attitudinal change has been identified, among which are.

i. **Forced compliance behavior:** Forced compliance takes place when someone is made to carry out an action that conflict with his or her beliefs. This creates dissonance between their cognition and their belief. Hence, an assessment will need to be carried out to reduce the dissonance between the action they carried out and their belief. This has been tested experimentally by Festinger and Carlsmith in 1959.

ii. **Decision making**: Brehem, J.W. was the first to investigate the relationship between decision making and dissonance. When we must make decision between two things with their advantage and disadvantage, dissonance sets in as we struggle to choose between both alternatives. To reduce the dissonance, we must choose one alternative and live with its advantages as well as disadvantages.

iii. **Effort**: Humans generally place value on what they achieved through considerable effort, like education for example. If we put in effort into an activity which we place value on, and the activity turned out poorly, dissonance sets in. To minimize this dissonance, we persuade ourselves that the activity was enjoyable. This method of dissonance reduction is termed as "effort justification". Cognitive dissonance can be reduced and managed in the following ways.

i. Change one or more of the attitudes and beliefs in conflict to produce a cognitive balance.

ii. Accept new knowledge that dislodges the dissonant attitude and beliefs.

iii. Decrease the importance and attractiveness of the attitude and belief (cognition) while increasing the importance of the chosen. (Saul, 2023). It is worth mentioning that there is a problem from a scientific standpoint as we are unable to observe cognitive dissonance physically, meaning it cannot be measured objectively. Furthermore, there are also individual opinions if people truly act as cognitive dissonance theory predicts. (Saul, 2023). In application, when science students are presented with the knowledge of change of subject formula, dissonance sets in, and they must adjust their mental cognition to reduce the dissonance by accepting the new knowledge change of subject formula provides thereby solving more physics problems.

Research Instrument and Method of Study

Quasi-experimental research design was adopted for this study, using treatment group (those taught change of subject formula) and control group (those taught without). The treatment group was taught independently from the control group. Random sampling technique was used to obtain 150 students (10% of population). The 150 students were chosen from Community Secondary School (C.S.S) Omoku in Ogba/Egbema/Ndoni Local Government Area of Rivers State. The chosen students were truly those in Senior Secondary School One (S.S.1). They were chosen because it is from S.S.1 that students begin to develop negative attitude toward Physics as a subject. The treatment group comprise of 75 students (40 males and 35 females) whereas the control group comprise of 75 students (36 male and 39 female). Four-point modified likert scale [SA=Strongly Agree (4), A=Agree (3), D=Disagree (2) and SD=Strongly Disagree (1)] was used to develop a questionnaire consisting of 12 items for measuring students' attitude, titled "Attitude of Students towards Learning of Physics". While Physics Achievement Test (PAT) consisting of 20 objective test items with three (3) distracters and one correct option lettered A-D, were created on the topic; "Motion in one dimension" to measure the problem-solving skills of Physics students. The test was administered for one hour thirty minutes. Each correct answer was scored five (5) marks, totaling 100 marks. The questionnaire was administered for thirty (30) minutes after teaching of change

of subject formula, motion in one dimension and administering of post-test in the school premises. Kuder-Richardson's formula-21 was used to obtain reliability co-efficient of 0.993. On the grounds of high reliability index, the instrument was considered appropriate to be used in conducting the study.

Results

The results of the study were analyzed using mean, standard deviation, and column chart. Decision was based on; accept attitude mean score of 2.5 and above as positive learning attitude. Meanwhile, inferential statistics such as independent t-test and Pearson correlation were used to determine difference and relationship between variables involved in this study. Decision making was based on; reject the null hypothesis if the calculated p-value is less than the alpha value, 0.05, otherwise do not reject.

Research Question 1: What is the difference in attitude of Physics students taught change of subject formula and those taught without?

Table 1: Showing Treatment Group and Control Group Students Attitude towards the Learning of Physics.

No.	Item	Variables	$(\bar{x})$	SD	Decision
1.	Physics class is exciting, and I always look forward to it.	Treatment	3.36	0.58	Positive
		Control	2.69	0.99	Positive
2.	The knowledge of Physics gives me a new perspective of the working of the world around me.	Treatment	3.37	0.48	Positive
		Control	2.56	0.74	Positive
3.	Given time and effort, virtually anyone can study and understand Physics.	Treatment	3.34	0.46	Positive
		Control	2.61	0.76	Positive
4.	Rather than memorizing, I can apply Physics laws and principle in a real-life situation.	Treatment	3.28	0.62	Positive
		Control	2.20	0.85	Negative
5.	Physics problems are too hard to solve.	Treatment	1.77	0.76	Positive
		Control	2.41	0.90	Positive
6.	I dislike the mathematical aspect of Physics.	Treatment	1.72	0.66	Positive
		Control	2.60	0.98	Negative
7.	I delight myself in solving problems in Physics.	Treatment	3.31	0.57	Positive
		Control	2.36	0.71	Negative
8.	I can manipulate Physics formulae to solve Physics problems.	Treatment	3.29	0.46	Positive
		Control	2.24	0.83	Negative
9.	The most significant aspect of problem solving in Physics is stating the right formula.	Treatment	3.31	0.46	Positive
		Control	2.28	0.95	Negative
10.	Problem solving is not difficult if we understand the question and the physical quantities present and affecting it.	Treatment	3.25	0.49	Positive
		Control	2.19	0.76	Negative
11.	Physics equations and formulae are not helpful in understanding and remembering Physics laws and concepts.	Treatment	1.55	0.50	Positive
		Control	1.99	0.81	Positive
12.	I like the challenge Physics assignment offers.	Treatment	3.23	0.69	Positive
		Control	2.17	0.87	Negative

	Overall mean and SD	**Treatment**	**2.90**	**0.56**	**Positive**
		Control	**2.36**	**0.85**	**Negative**

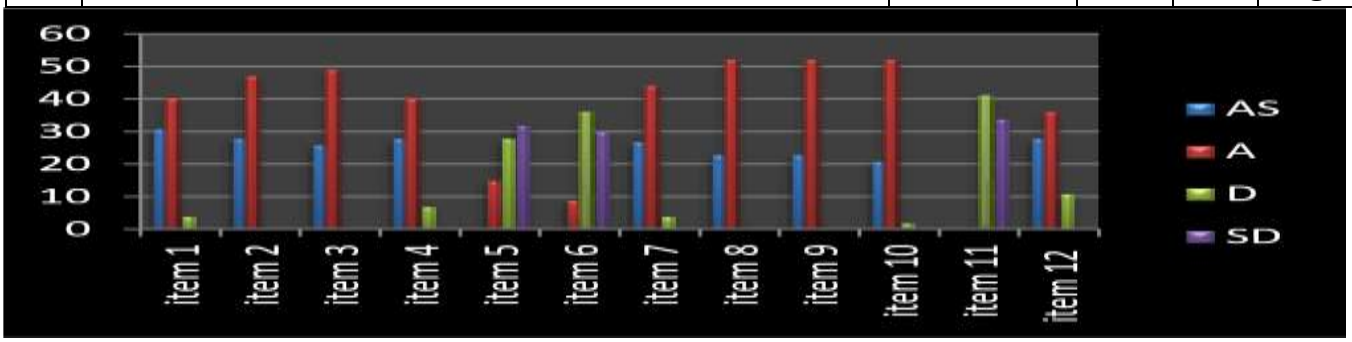
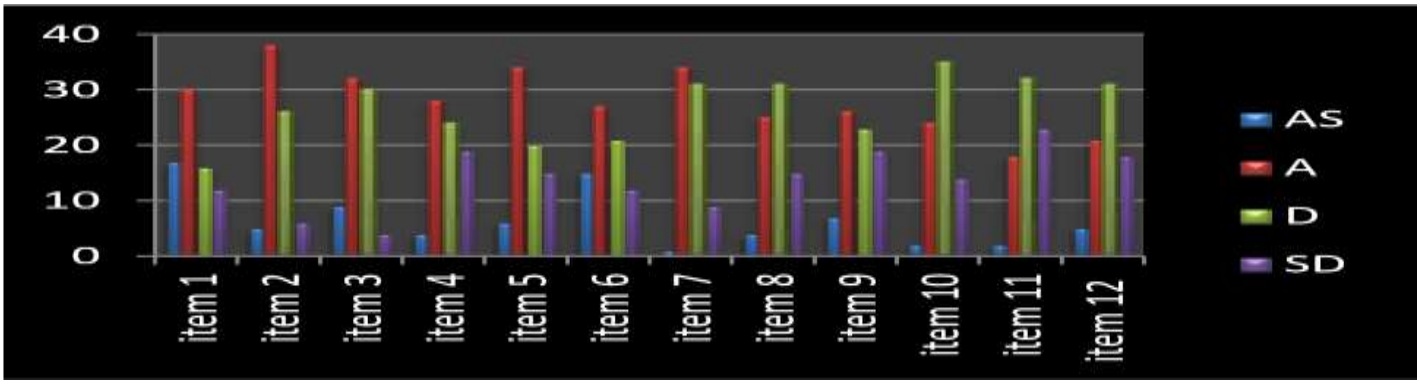


Fig. 1: Column Chart showing treatment group attitude towards learning of Physics. Fig. 2: Column Chart showing control group attitude towards learning of Physics.



Research Question 2: What is the difference in attitude of male and female Physics students taught change of subject formula?

Table 2: Showing Treatment Group (Male and Female) Students Attitude towards the Learning of Physics.

No.	Item	Variables	($\bar{x}$)	SD	Decision
1.	Physics class is exciting, and I always look forward to it.	Male	3.50	0.50	Positive
		Female	3.20	0.62	Positive
2.	The knowledge of Physics gives me a new perspective of the working of the world around me.	Male	3.50	0.50	Positive
		Female	3.23	0.42	Positive
3.	Given time and effort, virtually anyone can study and understand Physics.	Male	3.45	0.50	Positive
		Female	3.23	0.42	Positive
4.	Rather than memorizing, I can actually apply Physics laws and principle in a real-life situation.	Male	3.48	0.50	Positive
		Female	3.06	0.67	Positive
5.	Physics problems are too hard to solve.	Male	1.72	0.74	Positive
		Female	1.83	0.77	Positive
6.	I dislike the mathematical aspect of Physics.	Male	1.63	0.70	Positive
		Female	1.83	0.61	Positive
7.	I delight myself in solving problems in Physics.	Male	3.50	0.50	Positive

		Female	3.08	0.55	Positive
8.	I am able to manipulative Physics formulae to solve Physics problems.	Male	3.35	0.48	Positive
		Female	3.23	0.42	Positive
9.	The most significant aspect of problem solving in Physics is stating the right formula.	Male	3.38	0.48	Positive
		Female	3.23	0.42	Positive
10.	Problem solving is not difficult if we have an understanding of the question and the physical quantities present and affecting it.	Male	3.40	0.49	Positive
		Female	3.09	0.44	Positive
11.	Physics equations and formulae are not helpful in understanding and remembering Physics laws and concepts.	Male	1.53	0.50	Positive
		Female	1.57	0.50	Positive
12.	I like the challenge Physics assignment offers.	Male	3.45	0.55	Positive
		Female	2.97	0.74	Positive
	Overall mean and SD	**Male**	**2.99**	**0.54**	**Positive**
		Female	**2.80**	**0.55**	**Positive**

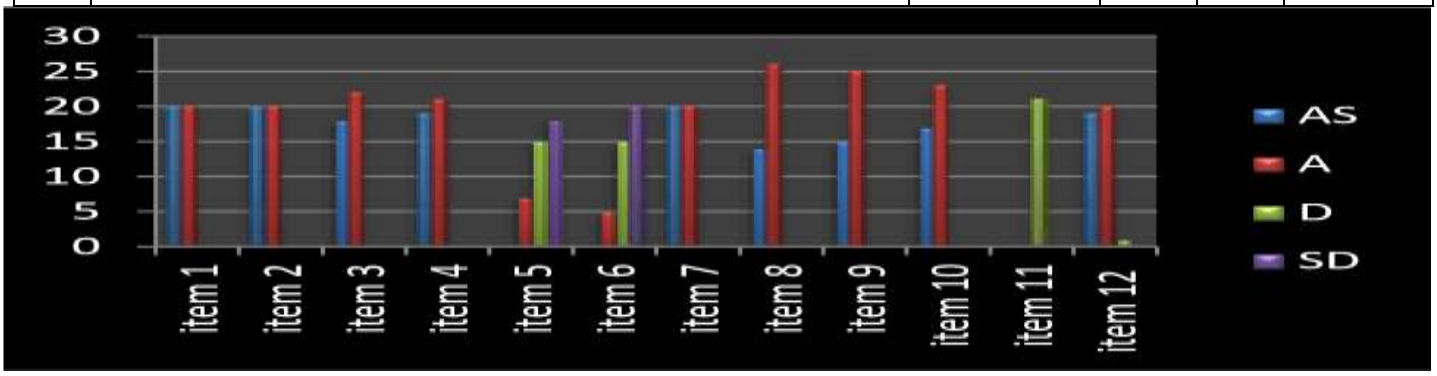
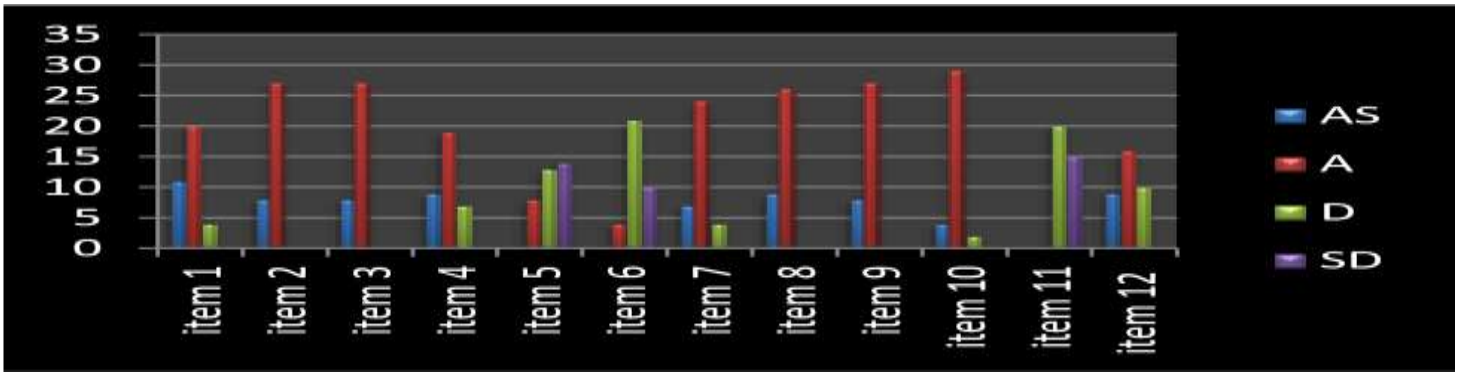


Fig. 3: Column Chart showing male treatment group Fig. **4: Column Chart showing female treatment group attitude towards learning of Physics. Attitude towards learning of Physics.**



Research Question 3: What is the difference in the mean problem-solving score of Physics students taught change of subject formula and those taught without?

Table 3: Showing Mean Problem-Solving Score of Treatment and Control Groups

	Treatment Group (N=75)		Control Group (N=75)	
	$(\bar{x})$	SD	$(\bar{x})$	SD
Pre – test	20.20	9.85	19.00	10.92

Post – test	70.07	8.77	54.47	10.97
Mean gain score	49.87		35.47	

Research Question 4: What is the difference in the mean problem-solving score of male and female Physics students taught change of subject formula?

Table 4: Showing Mean Problem-Solving Score of Male and Female Treatment Group

	Male (N=40)		Female (N=35)	
	$(\bar{x})$	SD	$(\bar{x})$	SD
Pre – test	21.25	9.40	19.00	10.20
Post – test	72.75	9.48	67.00	6.68
Mean gain score	51.50		48.00	

Hypothesis 1: There is no significant difference between the attitude of Physics students taught change of subject formula and those taught without.

Table 5: Showing Independent Sample t – test of Significant between Attitude of Treatment and Control Groups towards Learning of Physics

Variable	$(\bar{x})$	SD	N	df	P-Value	T-Crit.	Result
Treatment Group	34.76	2.81	75	129	.0000	1.9785	Rejected
Control Group	28.33	4.21	75				

Hypothesis 2: There is no significant difference between the attitude of male and female Physics students taught change of subject formula.

Table 6: Showing Independent Sample t – test of Significant between Attitude of Male and Female Physics Students Taught Change of Subject Formula

Variable	$(\bar{x})$	SD	N	df	P-Value	T-Crit.	Result
Male	35.83	2.14	40	61	.0005	1.9996	Rejected
Female	33.54	2.98	35				

Hypothesis 3: There is no significant difference in the mean problem-solving score of Physics students taught change of subject formula and those taught without.

Table 7: Showing Independent Sample t – test of Significant between the Mean Problem-Solving Score of Treatment and Control Groups

Variable	$(\bar{x})$	SD	N	df	P-Value	T-Crit.	Result
Treatment Group	70.07	8.77	75	141	.0000	1.9769	Rejected
Control Group	54.47	10.97	75				

Hypothesis 4: There is no significant difference in the mean problem-solving score of male and female Physics students taught change of subject formula.

Table 8: Showing Independent Sample t – test of Significant between the Mean Problem-Solving Score of Male and Female Physics Students Taught Change of Subject Formula

Variable	$(\bar{x})$	SD	N	df	P-Value	T-Crit.	Result
Male	72.75	9.48	40	70	.0035	1.9944	Rejected
Female	67.00	6.68	35				

Hypothesis 5: There is no relationship between attitude and problem-solving skills of Physics students taught change of subject formula.

Table 9: Showing Pearson Correlation Analysis between Learning Attitude and Problem-Solving Skill

Variable	Learning Attitude	Problem solving skill
Learning Attitude	1	.3469
Problem solving skill	.3469	1
	N=75	N=75

Discussion of findings

This study set out to find the impact of the knowledge of change of subject formula on attitude and problem-solving skills of senior secondary school one Physics students. The study reveals that Physics students taught change of subject formula showed positive learning attitude towards Physics, as data in table 1 discloses that Physics students taught change of subject formula had an overall attitude mean score of 2.90 and SD of 0.56. The mean 2.90 is greater than the mean score of 2.50, therefore accepted as positive learning attitude. Whereas, the control group, those taught without change of subject formula had an attitude mean score of 2.36 and SD of 0.85. The mean 2.36 is less compared to the mean score of 2.50, hence taken as negative learning attitude. To see if this difference in mean score is significant, hypothesis 1 was tested. Data analysis in table 5 showed that the P-value (.0000) is less than the alpha value of 0.05. Therefore, the null hypothesis is thus, rejected and the alternative hypothesis upheld. Hence, there is a significant difference in learning attitude of Physics students taught change of subject formula and those taught without. This result agrees with the findings of Erdemir (2009), that Physics student who can manipulate formulas and solve more Physics problems show positive attitude towards the learning of Physics. Furthermore, in the case of gender, result in table 2 shows that, the male Physics students in the treatment group had an overall attitude mean score of 2.99 and SD of 0.54, while their female counterparts had an overall attitude mean score of 2.80 and SD of 0.55. The means 2.99 and 2.80 is greater than the mean score of 2.50, hence taken as positive learning attitude. Meaning that, both male and female had a positive learning attitude towards Physics after being taught change of subject formula. But the mean of the males is greater than the mean of females by 0.19. To ascertain if this observed difference is significant or not, hypothesis 2 was tested. And the t-test analysis in table 6 gives a P-value of .0005 which is less than the alpha value of .05, thus the null hypothesis is rejected, and we uphold the alternative hypothesis which states that, there is a significant difference in the learning attitude of male and female Physics students taught change of subject formula. This finding agrees with those of Trivedi and Sharma (2013) and Erdemir (2009). But disagrees with those of Giricho (2018) and Nwokolo and Apaokwu (2016), who did not find any significant difference in the learning attitude of male and female Physics students taught change of subject formula. Ongoing further, results in table 3 shows that, the treatment group had a pre-test mean score of 20.20 with SD of 9.85 and a post-test mean score of 70.70 and SD of 8.77, having a mean gain score of 49.87. Whereas the control group had a pre-test mean score of 19.00 with SD of 10.92 and a post-test mean score of 54.47 with SD of 10.97, coming out with a mean gain score of 35.47. This data shows that the treatment group outperformed their counterpart in the control group with a mean gain difference of 19.00. To test if this difference is significant or not, hypothesis 3 was tested and t-test data analysis in table 7 revealed a P-value of .0000 which is less than the alpha value of .05. On this ground, the null hypothesis is thus rejected, and we uphold the alternative hypothesis. Meaning there is a statistic significant difference in the problem-solving skills of Physics students taught change of subject formula and those taught without. This implies

that the knowledge of change of subject formula improves the problemsolving skills of Physics students. This result agrees with those of Batta and Mumuni (2018) and Tukur (2018) who found out that, the knowledge of change of subject formula improves problem solving skills of secondary school Physics students. Also, results in table 4 displays a pre-test mean score of 21.25 with SD of 9.40 and a post-test mean score 72.75 with SD of 9.48, showing a mean gain score of 51.50 for males in the treatment group. On the other hand, the females in the treatment group had a pre-test mean score of 19.00 with SD of 10.20 and a post-test mean score of 67.00 with SD of 6.68, having a mean gain score of 48.00. It is obvious that the males outdone their female colleague with a mean gain difference of 3.50. On testing hypothesis 4, the t – test data analysis reveals a Pvalue of .0035 which is less than the alpha value of .05. Thus, the null hypothesis is rejected. Therefore, there is a significant difference in the mean problem-solving scores of male and female Physics students taught change of subject formula. This suggests that the males solved more Physics problems than their female counterpart after being taught change of subject formula. This finding agrees with those of Trivedi and Sharma (2013) who found that the males outdid their female counterpart after being taught change of subject formula. Moreover, the Pearson correlation in table 9 shows that there is no relationship between attitude and improved problem-solving skills of Physics students taught change of subject formula ($r = .3469$, $p < 0.05$). Therefore, the null hypothesis is thus accepted. Meaning that the improved problem-solving skills of Physics students taught change of subject formula did not depend on their attitude being positive or negative, but on the knowledge of change of subject formula. This result agrees with those of Visser (2007) who found out that attitude towards Physics has no connection with problem solving skills in Physics. Whereas Ali and Awan (2013) found out a positive relationship between attitude towards Physics and problem-solving skills, as Physics students with positive attitude towards Physics solved more Physics problems.

Conclusion

This study was conducted with secondary school one Physics students to determine the impact of the knowledge of change of subject formula on attitude and problem-solving skills. Results show that the "knowledge of change of subject formula" impacted and improved the attitude of secondary school Physics students towards the learning of Physics, as well as their problemsolving skills. Furthermore, the study also revealed that the attitude of males and their problemsolving skills improve significantly more than their female counterpart. However, there was no relationship between attitude and problem-solving skills of secondary school Physics students. Therefore, notwithstanding that change of subject formula is a topic treated in mathematics, it should be included in the Physics curriculum as a topic taught in Senior Secondary one (S.S.S.1) first term work as it is an indispensable knowledge needed for proper understanding of Physics concepts, laws, principles, formulas, equations, and problems.

Recommendations

The following recommendations were put forward based on findings of the study.

1. The topic change of subject formula should be included in the Physics curriculum as a topic taught in Senior Secondary School one (S.S.S. 1) first term work.
2. Seeing that the knowledge of change of subject formula is crucial for problem solving in Physics, the best method for the teaching of change of subject formula should be investigated.

3. The study should be replicated using a different population and area to determine the impact of the knowledge of change of subject formula on attitude and problem-solving skills of secondary school Physics students.

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