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UTILIZING INTERACTIVE STUDENTS' NOTEBOOK WITH FEEDBACK STRATEGIES TO ENHANCE SECONDARY STUDENTS' SCIENCE PROCESS SKILLS ACQUISITION, PERFORMANCE IN AND ATTITUDE TOWARDS PHYSICS

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Abstract:
The study investigated how utilizing interactive students' notebook with feedback strategies could enhances science process skills acquisition, performance in and attitude towards physics in Plateau state, Nigeria. Three research questions and three null hypotheses formulated guided the study. The study adopted quasi-experimental research design. The population consists of 3,182 Senior Secondary (SS) II Physics students. A sample of 113 SS II Physics students in four intact classes was used for the study. Physics Students' Academic Performance Test (PSAPT) with reliability coefficient of 0.97, Test of Physics Related Attitude (TOPRA) with reliability coefficient of 0.84 and Test of Science Process Skills Acquisition (TOSPSA) with reliability coefficient of 0.98 were used for data collection. Data were analyzed using mean and standard deviation Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. It was found that there was significant difference in the mean attitude scores towards physics [$F(1,112) = 4.675$; $p = 0.033 < 0.05$], mean skill acquisition scores [$F(1, 112) = 54.083$; $p = 0.000 < 0.05$] and mean performance scores [$F(1,112) = 18.107$; $p = 0.000 < 0.05$]

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of students taught using the interactive students' notebook with feedback and those taught using the conventional strategy. It was recommended among others that Physics teachers should employ interactive students' notebook with feedback strategy in their classroom interaction when teaching physics. It promotes process skills acquisition in Physics and performance in Physics. In service training, seminars, work-shops and symposia should be organized by the state and federal ministry of education to train physics teachers on how to use interactive students' notebook with feedback in teaching the subject.

Keywords: feedback strategy, science process skills acquisition, performance, attitude, physics

1. Introduction

Science as a field of study has done a lot for mankind. For instance, life has been made a lot easier for man as a result of the advancements in science. Through science, man has been able to better understand his environment and this has enabled him to manipulate the conditions of his environment to suit his own benefit. Its impact is felt in every sphere of life. Physics as a science subject is very important in the economic development of all countries of the world. It is the most basic of sciences and its concepts and techniques underpin the progress of all other branches of science (Dakang, 2015). It is a cross-cutting discipline that has applications in many sectors of economic development including health, agriculture, water, energy, information and communication technologies (Akinbobola, 2009). Thus, Physics occupies a central position in the science curriculum and plays a very vital role in scientific advancement that affects the lives of all mankind. Despite this importance attached to science, several research reports indicate that students' performance in secondary school science subjects is poor especially Physics (Achor, 2003; Ukwungu, 2006; Akinbobola, 2009; Adegoke, 2011; Aina, 2013; Dakang, 2015). Available statistics from West African Examination Council Chief Examiners Reports (WAEC, 2013, 2014, 2015, 2016, 2017, 2018 & 2019) on senior secondary school students' performance in Physics reveal a poor performance trend at the Senior School Certificate Examination (SSCE). Furthermore, these Chief Examiners' reports have implicated poor performance in the aspect of light, its transmission and application. In particular there was poor diagrammatic representation and handling of basic calculations on the topic. Available evidence has revealed that the students' poor performance in Physics is linked to poor pedagogical methods used by the teachers (Owolabi, 2004; Keban & Erol, 2011; Aina, 2013; Dakang, 2015). In line with this, Mankilik (2019) reveals that the analysis of students' performance in physics shows a consistent high failure in Jos metropolis which is applicable to other schools in Plateau state as obtained in West African Examination Council chief examiners reports from 2012-2016 in senior secondary students' performance in physics. For 2012 (41.35%); 2013 (33.83%); 2014 (53.83%); 2015

(51.82%) and 2016 (21.16%). He further said the situation is similar in Chemistry, Biology and Mathematics. Similarly, the NECO Results in Physics showed that; 2012 (48.91%); 2013 (32.94%); 2014 (31.27%); 2015 (19.11%) and 2016 (17.74%).

The conventional instructional strategy such as the lecture method often employed in teaching Physics has not improved students' performance in the subject to any appreciable extent (Akinbobola, 2009; Adegoke, 2011; Bello, 2011; Aina, 2012; Aina, 2013). This implies that the teaching of Physics has not led to students understanding of the concepts. Therefore, there is a need to find other pragmatic teaching strategies such as the interactive students' notebook with feedback strategy. According to Chesbro (2008), interactive students' notebook is an instructional tool that promotes the application of a strategy that provide students with opportunities to record what they learn and to personalize their work in meaningful ways through reflection.

Interactive student Notebooks (ISNs) are spiral notebooks or composition books that are organized into two parts. The right side contains input and the left side contains students output (Waldman & Crippen, 2009; Teachers Curriculum Institute, 2012). Input (right side) consists of information received through teacher lecture, notes, lab sheets and information obtained from text. The output (left side) contains students' interpretation and/or reflections and representations. The left side of ISNs belongs to the student and offers the student the opportunity to further scientific understanding with a section in which to make connections and extensions based on the knowledge and understanding of the content that was learned. The left side helps students to make sense of the investigation, allows them to think about experiments they just performed, and enables them to reflect and organize their thoughts (Shapiro, 2010). The use of the interactive students' notebook is one key strategy that may empower students to acquire science process skills, enhance performance and attitude in Physics (Waldman & Crippen, 2009; Mallozzi, 2013; Drew, 2018; Ergin & Aktamis, 2018).

Science process skills are cognitive and psychomotor skills which scientists employ in problem identification, objective inquiry, data gathering, transformation, interpretation and communication. Padilla (2010) described science process skills as abilities which can be developed by experience and which are used in carrying out mental operations and physical actions. Studies by Okoli (2006), assert that when one acquires the science process skills of observing, measuring, questioning, designing experiments, interpreting data, such a person becomes specially equipped with the tools required for scientific inquiry or problem-solving as well as ability to use these skills in the laboratory for a variety of investigations, especially using specific teacher feedback.

Specific teacher feedback enhances science learning when the feedback is related to how a student utilizes science process skills while performing a task or used to clarify misconceptions and redirect a students' learning. Wist (2006) and Marcarelli (2010) had earlier stressed this fact. Feedback that is timely, that clearly addresses the task at hand, and that is directly related to students' performance may be a powerful instructional strategy (Hattie & Timperley, 2007; Marzano, 2007; Marcerelli, 2010; Siewert, 2011),

especially when given firsthand experience through science process skills. Specific teacher feedback according to Siewert (2011) is a response made to students either verbally or non-verbally, that references a specific task, the process of a task, the student's self-regulation, and/or the student as a person. For feedback to be effective and improve student learning, it should be provided continuously (Cianci, Schaubroeck & McGill, 2010). Corrective and constructive feedback may be used to redirect a student's understanding of a concept, clear misconceptions and probes for more details or simply to affirm progress. Specific teacher feedback can stimulate students thinking, feelings and attitude.

Attitude is someone's disposition towards a particular object, a person, a thing or idea. Attitude towards Physics deals with the beliefs, interest, perception and aspiration, practicing habits, persistence and self-concept of students in dealing with Physics. Attitude plays a major role in the comprehensibility of Physics concepts. Dyel (2011) maintains that attitude can be described as a state of readiness, a tendency to act or react in a certain way. The author stress that attitude influences the participation rate of learners in Physics. In general, it refers to a learned disposition or tendency on the part of an individual to respond positively or negatively to a situation or another person. The enthusiasm with which students enter into any learning activity is determined by their attitude to that particular activity. Students seem to learn more efficiently those things that appear to interest them.

The persistent poor performance and negative attitude of students towards Physics coupled with poor science process skill acquisition exhibited by students in Physics at the senior school Certificate Examination level leaves one in doubt about the effectiveness of the teaching methods popularly used by Physics teachers in teaching the subject. It is obvious that for a nation to develop a sound basis for modern technology, the study of Physics is very important. Unfortunately, the teaching and learning of Physics is bedeviled by many factors among which are problem of poor science process skills acquisition, poor performance and negative attitude towards the subject. This problem has persisted for many years despite efforts to arrest the situation. There is evidence to attest to this fact that candidates show greater weaknesses in Physics, very few students pass with credits compared to other science subjects and it was therefore recommended by previous studies that more attention should be given to the teaching and learning of Physics.

When a subject is poorly taught, the learning will be haphazard and performance, process skills acquisition and attitude may be very poor. Among myriads of strategies being used, the interactive students' notebook with feedback has been reputed to enhance performance yet with dearth of research report in the study area. It is in this light that the researcher seeks to determine how utilization of the interactive students' notebook with feedback strategy of teaching can enhance students' science process skills acquisition, performance and attitude towards Physics irrespective of student gender. The problem of this study posed as a question therefore is, how does utilizing interactive students'

notebook with feedback enhance science process skills, performance and attitude towards Physics in Plateau state, Nigeria?

2. Purpose of the Study

The purpose of this study was to investigate how utilizing interactive students' notebook with feedback enhances science process skills, performance and attitude towards Physics in Plateau state, Nigeria. Specifically, the study focused on the following objectives:

1) Ascertain the effect of interactive students' notebook with feedback strategy on students' attitude towards Physics.
2) Determine the effect of interactive students' notebook with feedback strategy on students' science process skill acquisition in Physics.
3) Find out the effect of interactive students notebook with feedback on students' performance in Physics.

2.1 Research Questions

The following research questions raised were answered in this study:

1) What is the difference in the mean ratings of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy in their attitude towards Physics?
2) What is the difference in the mean science process skills acquisition scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy?
3) What is the difference in the mean performance scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy?

2.2 Hypotheses

The following null hypotheses formulated were tested at 0.05 level of significance:

1) There is no significant difference in the mean attitude ratings towards Physics between students taught using the interactive students' notebook with feedback and those taught using the conventional strategy.
2) There is no significant difference in the mean skill acquisition scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy.
3) There is no significant difference in the mean performance scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy.

3. Material and Methods

This study employed a quasi-experimental research design of non-randomized pre-test, post-test control group type. The study was carried out in Plateau State of Nigeria. The high records of poor performance and poor enrolment in Physics in Plateau State necessitate the present study. The population of the study consists of 3,182 senior secondary school two Physics students in all the secondary schools located in Plateau State of Nigeria (Planning, Research and Statistics Department Plateau State, 2018).

The sample for the study consists of 113 senior secondary school two Physics students located in Plateau State of Nigeria. A multistage sampling technique was used for the study. In all, two schools were for the experimental group (Interactive Students Notebooks Strategy group) and two schools were for the Control group (Conventional Strategy group). The experimental group consisted of 62 students made up of 29 male and 33 female students while the control group consisted of 51 students comprising 24 male and 27 female students.

Three instruments and three sets of lesson plans were used for the study. The instruments are:

1) Physics Students' Academic Performance Test (PSAPT).
2) Test of Physics Related Attitude (TOPRA).
3) Test of Science Process Skills Acquisition (TOSPSA).

4. Results and Discussion

Research Question One

What is the difference in the mean ratings of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy in their attitude towards Physics?

Table 1: Mean and Standard Deviation of Students Taught Physics Using the Interactive Students Notebook with Feedback and those Taught Using the Conventional Strategy in their Attitude towards Physics

Method		PreTOPRA	PostTOPRA	Mean Gain
Interactive Students' Notebook with Feedback	Mean	3.4153	3.8915	0.48
	N	62	62	
	Std. Deviation	.51816	.35014	
Conventional Strategy	Mean	3.4353	3.7461	0.31
	N	51	51	
	Std. Deviation	.52901	.36039	
Mean difference				0.17

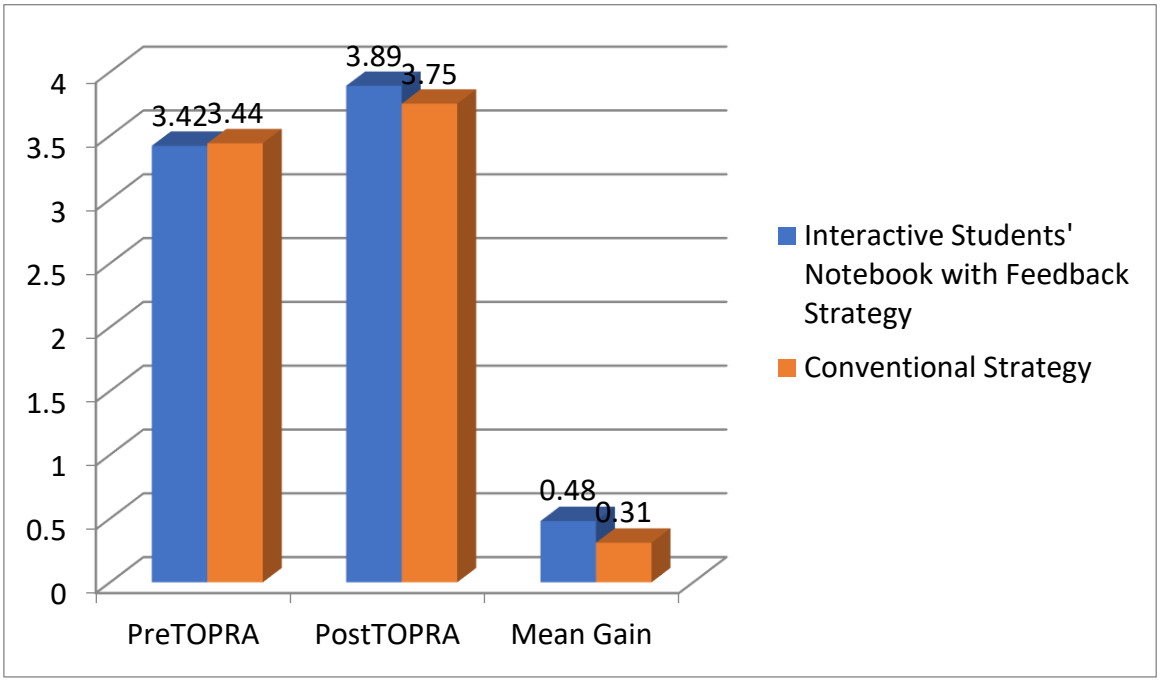

Figure 1: PreTOPRA, PostTOPRA and Mean Gain of Students Taught Physics Using the Interactive Students' Notebook with Feedback and those Taught Using the Conventional Strategy

The analysis of data on Table 1 shows the mean scores of students taught Physics using interactive students' notebook with feedback and those taught using the conventional strategy in their attitude towards Physics. The table shows that 62 students were taught Physics using interactive students' notebook with feedback while 51 students were taught Physics using conventional strategy. The table reveals that the mean scores of students taught Physics using interactive students' notebook with feedback is 3.42 with a standard deviation of 0.62 during pre-test and 3.89 with a standard deviation of 0.35 in posttest. The mean scores of students taught using conventional strategy is 3.44 with a standard deviation of 0.53 during pre-test and 3.75 with a standard deviation of 0.36 in posttest. The table further shows that the mean gain for interactive students' notebook with feedback is 0.48 while that of conventional strategy is 0.3. The summary of the Pretest, Posttest mean score of students taught Physics using interactive students' notebook with feedback and those taught using the conventional strategy is as shown in Figure 1. The difference in the mean scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy in their attitude towards Physics is 0.17 in favour of interactive students' notebook with feedback.

Research Question Two

What is the difference in the mean science process skills acquisition scores of students taught Physics using the interactive students notebook with feedback and those taught using the conventional strategy?

Table 2: Mean and Standard Deviation of Science Process Skills Acquisition Scores of Students Taught Physics Using the Interactive Students' Notebook with Feedback and those Taught Using the Conventional Strategy

Method		**PreTOSPSA**	**PostTOSPSA**	**Mean Gain**
Interactive Students' Notebook with Feedback	Mean	7.6129	28.0645	20.45
	N	62	62	
	Std. Deviation	2.65104	5.01758	
Conventional Strategy	Mean	7.2941	20.4706	13.18
	N	51	51	
	Std. Deviation	2.43552	5.92740	
Mean difference				7.27

The analysis of data on Table 2 shows the mean science process skills acquisition scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy. The table shows that 62 students were taught Physics using interactive students' notebook with feedback while 51 students were taught Physics using conventional strategy. The table reveals that the mean science process skills acquisition scores of students taught Physics using interactive students' notebook with feedback is 7.61 with a standard deviation of 2.65 during pre-test and 28.06 with a standard deviation of 5.02 in posttest. The mean science process skills acquisition scores of students taught using conventional strategy is 7.29 with a standard deviation of 2.44 during pre-test and 20.47 with a standard deviation of 5.93 in posttest. The table further shows that the mean gain for interactive students' notebook with feedback is 20.45 while that of conventional strategy is 13.18. The summary of the Pretest, Posttest mean score of students taught Physics using interactive students' notebook with feedback and those taught using the conventional strategy is as shown in Figure 2. The difference in the mean science process skills acquisition scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy is 7.27 in favour of interactive students' notebook with feedback.

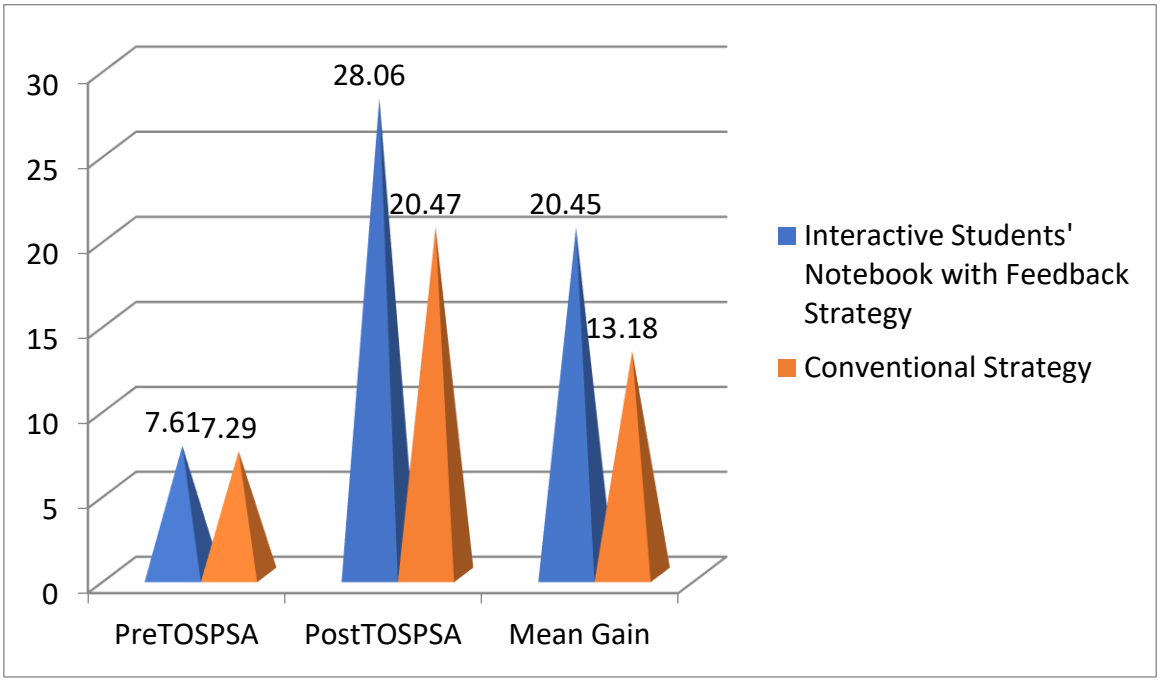

Figure 2: PreTOSPSA, PostTOSPSA and Mean Gain of Students Taught Physics Using the Interactive Students' Notebook with Feedback and those Taught Using the Conventional Strategy

Research Question Three

What is the difference in the mean performance scores of students taught Physics using the interactive students notebook with feedback and those taught using the conventional strategy?

Table 3: Mean and Standard Deviation of Performance Scores of Students Taught Physics Using the Interactive Students' Notebook with Feedback and those Taught Using the Conventional Strategy

Method		PrePSAPT	PostPSAPT	Mean Gain
Interactive Students' Notebook with Feedback	Mean	33.9194	48.5968	14.68
	N	62	62	
	Std. Deviation	8.78019	9.03265	
Conventional Strategy	Mean	38.7451	48.0392	9.25
	N	51	51	
	Std. Deviation	9.11667	8.96206	
Mean difference				5.43

The analysis of data on Table 3 shows the mean performance scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy. The table shows that 62 students were taught Physics using interactive students' notebook with feedback while 51 students were taught Physics using conventional strategy. The table reveals that the mean performance scores of

students taught Physics using interactive students' notebook with feedback is 33.92 with a standard deviation of 8.78 during pre-test and 48.60 with a standard deviation of 9.03 in posttest. The mean performance scores of students taught using conventional strategy is 38.75 with a standard deviation of 9.12 during pre-test and 48.04 with a standard deviation of 8.96 in posttest. The table further shows that the mean gain for interactive students' notebook with feedback is 14.68 while that of conventional strategy is 9.25. The summary of the Pretest, Posttest mean score of students taught Physics using interactive students' notebook with feedback and those taught using the conventional strategy is as shown in Figure 3. The difference in the mean performance scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy is 5.43 in favour of interactive students' notebook with feedback.

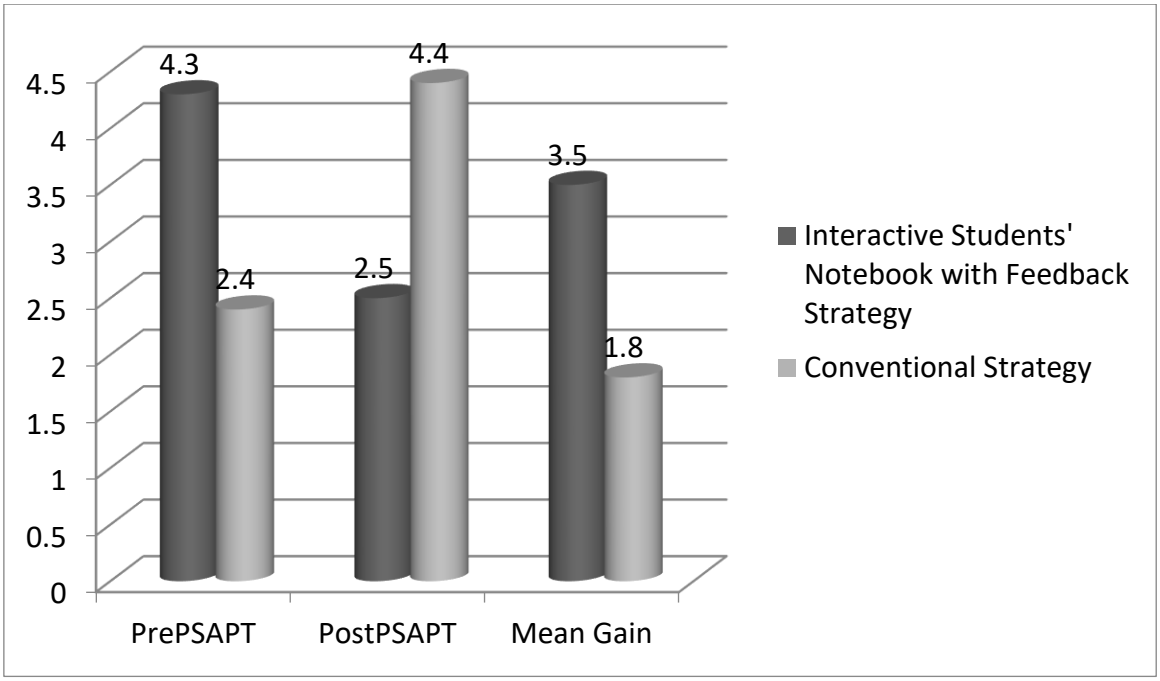

Figure 3: PrePSAPT, PostPSAPT and Mean Gain of Students Taught Physics Using the Interactive Students' Notebook with Feedback and those Taught Using the Conventional Strategy

Hypothesis One

There is no significant difference in the mean attitude ratings towards Physics between students taught using the interactive students' notebook with feedback and those taught using the conventional strategy.

Table 4: ANCOVA of Mean Attitude Scores towards Physics between Students Taught Using the Interactive Students' Notebook with Feedback and those Taught Using the Conventional Strategy

Dependent Variable: PostTOPRA						
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	.596[a]	2	.298	2.347	.100	.041
Intercept	36.137	1	36.137	284.567	.000	.721
PreTOPRA	.004	1	.004	.032	.859	.000
Method	.594	1	.594	4.675	.033	.041
Error	13.969	110	.127			
Total	1668.591	113				
Corrected Total	14.565	112				
a. R Squared = .041 (Adjusted R Squared = .023)						

Table 4 reveals that $F(1,112) = 4.675$; $p = 0.033 < 0.05$. Since p is less than 0.05, the null hypothesis is rejected. This implies that there is significant difference in the mean attitude scores towards Physics between students taught using the interactive students' notebook with feedback and those taught using the conventional strategy. Thus, it can be concluded that based on evidence from data analysis there is significant difference in the mean attitude scores towards Physics between students taught using the interactive students' notebook with feedback and those taught using the conventional strategy in Physics classes. The partial Eta square of 0.041 was obtained for the strategy meaning that only 4.1% of the Physics students' attitude score can be attributed to the strategies employ in the teaching Physics.

Hypothesis Two

There is no significant difference in the mean skill acquisition scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy.

Table 5: ANCOVA of Mean Skill Acquisition Scores of Students Taught Physics Using the Interactive Students' Notebook with Feedback and those Taught Using the Conventional Strategy

Dependent Variable: PostTOSPSA						
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	1617.334[a]	2	808.667	27.047	.000	.330
Intercept	7189.122	1	7189.122	240.454	.000	.686
PreTOSPSA	3.658	1	3.658	.122	.727	.001
Method	1616.973	1	1616.973	54.083	.000	.330
Error	3288.790	110	29.898			
Total	73496.000	113				
Corrected Total	4906.124	112				
a. R Squared = .330 (Adjusted R Squared = .317)						

Table 5 shows that F(1,112) = 54.083; p = 0.000< 0.05. Since p is less than 0.05, the null hypothesis is rejected. This implies that there is significant difference in the mean skill acquisition scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy. Thus, it can be concluded that based on evidence from data analysis there is significant difference in the mean skill acquisition scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy in Physics classes. The partial Eta square of 0.330 was obtained for the strategy meaning that 33.0% of the Physics students' skill acquisition scores can be accounted for by the strategies employ in the teaching of Physics.

Hypothesis Three

There is no significant difference in the mean performance scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy.

Table 6: ANCOVA of Mean Performance Scores of Students Taught Physics Using the Interactive Students' Notebook with Feedback and those Taught Using the Conventional Strategy

Dependent Variable: PostPSAPT						
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	5835.669[a]	2	2917.834	101.382	.000	.648
Intercept	2249.771	1	2249.771	78.170	.000	.415
PrePSAPT	5826.970	1	5826.970	202.461	.000	.648
Method	521.142	1	521.142	18.107	.000	.141
Error	3165.871	110	28.781			
Total	273111.000	113				
Corrected Total	9001.540	112				
a. R Squared = .648 (Adjusted R Squared = .642)						

Table 6 shows that F(1,112) = 18.107; p = 0.000< 0.05. Since p is less than 0.05, the null hypothesis is rejected. This implies that there is significant difference in the mean performance scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy. Thus, it can be concluded that based on evidence from data analysis there is significant difference in the mean performance scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy in Physics classes. The partial Eta square of 0.141 was obtained for the strategy meaning that 14.1% of the Physics students' performance scores can be attributed to the strategies employ in the teaching Physics.

Result of hypothesis one revealed that there is significant difference in the mean attitude ratings wards Physics between students taught using the interactive students' notebook with feedback and those taught using the conventional strategy. This means that the use of interactive students' notebook with feedback strategy enhances students' attitude towards Physics more than conventional strategy.

The result of hypothesis two revealed that there is significant difference in the mean skill acquisition scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy. This means that the use of interactive students' notebook with feedback strategy enhances students' skill acquisition in Physics than conventional strategy. Thus, Physics could be better taught using interactive students' notebook with feedback strategy than conventional strategy to enhance skill acquisition. Science as a dynamic process of seeking knowledge, an enterprise that involves students searching, investigating and seeking verification of natural phenomena requires feedback which is interactive with students' notebook. The use of interactive students' notebook with feedback in the present study as a hands-on-strategy places the students in a problem-solving situation and surrounds them with appropriate materials. This enriched environment enables them process information with a view to solving scientific problems and therefore enhances the students' scientific skill acquisition in Physics.

Result of hypothesis three revealed that there is significant difference in the mean performance scores of students taught Physics using the interactive students' notebook with feedback and those taught using the conventional strategy. This means that the use of interactive students' notebook with feedback strategy enhances students' performance in Physics more than conventional strategy. Therefore, Physics could be better taught using interactive students' notebook with feedback strategy than conventional strategy to enhance academic performance.

5. Recommendations

The following recommendations were made in the light of the findings of this study:

1) Physics teachers should employ interactive students notebook with feedback strategy in their classroom interaction when teaching Physics as the strategy has the capacity to enhance male and female students' attitude towards Physics, promotes process skills acquisition in Physics and performance in the subject.
2) Physics teachers should regularly provide the structure and opportunity for learners to employ interactive students' notebook with feedback as learning strategy.
3) In service training, seminars, work-shops and symposia should be organized by the state and federal ministry of education to train Physics teachers on how to use interactive students' notebook with feedback in teaching the subject.

4) Interactive students' notebook with feedback strategy should be included in the training package of teacher education programme both in colleges of education and at university level to ensure that teacher-trainees acquire necessary skills to effectively implement the techniques.

6. Conclusion

The study has established that the use of interactive students' notebook with feedback strategy in teaching Physics contents enhances students' attitude towards Physics, promotes students' process skills acquisition in Physics and as well as students' performance in Physics better than conventional strategy. It was also established that interactive students' notebook with feedback strategy is gender friendly with reference to students' attitude towards Physics and students' process skills acquisition in Physics. It was equally established that interactive students' notebook with feedback strategy is gender sensitive with reference to students' performance in Physics. It was concluded that concepts in Physics are better taught via interactive students' notebook with feedback strategy, since the students find themselves reassessing the importance of Physics and develop positive attitude towards the teaching and learning of Physics, acquire scientific process skills and performed better in Physics. However, gender of students does not interact with methods to affect students' attitude, acquisition of process skill and academic performance in physics.

Conflict of Interest Statement
There are no conflicts of interest to be declared.

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