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GENERATIVE LEARNING STRATEGY: PHYSICS INTERVENTION FOR IMPROVED ACADEMIC ACHIEVEMENT AND MOTIVATION AMONG COLLEGE STUDENTS IN GHANA

Appiah-Twumasi, Eric
Berekum College of Education, Ghana

Abstract

The study examined the effect of Generative Learning Strategy on College of Education students' academic achievement and motivation to learn physics concepts. The research design employed was pretest-intervention-posttest, non-equivalent comparison-group design using a total of 98 College of Education students' of Berekum College of Education. Two research instruments, Multiple Choice Items (MCI) and Motivation Perception Survey on Generative Learning (MPSGL) were used to gather data for the study. MCI was used to gather data on students' academic progression in physics before and after the introduction of the intervention while MPSGL was used to assess students' motivation in physics studies before and after the intervention. Mean, standard deviation, mean gain and effect size were calculated and used to answer the research questions. A t-test was used to test the hypotheses. The results indicated that students instructed using Generative Learning Strategy performed better in the MCI test than those instructed using lecture method fused with demonstration and discussion. Also, the results indicated that Generative Learning Strategy increased students' motivation to learn physics. No significant difference in the performance by gender and high and low achievers with regard to the using Generative Learning Strategy were discovered. The implications of the results obtained are that, Physics teachers intending their students to improve their academic performance should consider using Generative Learning Strategy in teaching.

Keywords: generative learning; achievement; motivation; gender; college students.

Introduction

Some researchers in recent years have highlighted the decline in the number of students wishing to continue with the study of Physics (Ho & Boo, 2007). A number of factors have been identified by researchers as the contributing factors to this decline. Some students associate this decline to the subjects being boring, irrelevant and too abstract. The literature (Sillito & Mackinnon, 2000; Boyes & Dickson, 2003) also noted that, the study of physics in schools and universities is spiralling into decline as many students believe it is too difficult. Consequently, this has negative effects on the academic achievement of physics students.

The kind of learning environment, interaction, and teaching methods employed by physics teachers at any level of education may also be attributed to the decline in the number of students willing to study physics. Consequently, the utilisation of appropriate instructional methods could be beneficial to halt this decline. The instructional method which is right for a particular lesson depends on factors such as the age and cognitive development of the students, what the students already know, and what they need to know to succeed in the subject, the subject matter, students' interests and the objective of the lesson. Research has shown that the performance, motivation and interest of learners to learn significantly depend on the teaching strategies adopted by teachers (Makgato & Mji, 2006).

Literature suggests that the extent to which learners learn depends on their level of motivation which can be stimulated by the nature of the learning environment and the teaching strategy utilised by the teacher (Mwanmwenda, 2010). Mwanmwenda further added that the teacher's role is to influence the motivation of learners to learn by using teaching strategies that can impact learners' attitudes towards learning, build on their self-concepts and raise their educational aspirations. Mwanmwenda's assertion would be useful if teachers or instructors use student-centered teaching methods rather than teacher-centered methods.

In the teacher-centered Physics classroom, teachers teach Physics concepts through discussion and lecturing. Physics teachers in teacher-centered Physics classrooms describe and define concepts and write related equation and keywords on the board. Also, students take notes and after the teacher's explanations, the concepts are discussed through teacher-directed questions. Consequently, students in teacher-centered classrooms are likely to be passive learners instead of active learners.

According to Pickering and Pollock (2001), active or participatory learning by students is the effective, efficient, and superior instructional approach for teaching and learning. The assertion of Pickering and Pollock was corroborated by Frankel and Wallen (2007) that the use of student-centered learning can increase the mastery of Physics concepts than the teacher-centered teaching. One of such student-centered learning models is Generative Learning Strategy (George, 2011). On the activity-based Generative Learning, students are required to prepare themselves mentally for understanding of the material to be taught. This implies that in the Generative Learning Strategy, the active students take greater part in the learning process and produce the knowledge with the connections between mental concepts formation.

Generative Learning Strategy is a step-by-step learning strategy, which is based on students' views and experiences in active classroom learning (Ogunleye & Babajide, 2011). They further noted that, the model of Generative Instructional Strategy is a functional model of instruction and not a structural model. Ogunleye and Babajide concluded that as a functional model of instruction, it focuses on the cognitive processes that learners use to comprehend concepts as well as the teaching and instructional procedures useful for increasing comprehension.

Generative Learning Strategy is a student-centered strategy where pieces of information retrieved from students' memories on a particular concept are explained and modified by the students themselves. Generative Learning Strategy allows for individualised form of learning and empowers learners with the ability to express their personal views. According to Wittrock-(1974), the basis of the Generative Learning Strategy is premised on the theory of schemata. The concept of schemata proposes that the learning process is based on the memory that is formerly stored in individuals' brains, where new information is added to the individual students' long term memory which becomes a component of the individual's knowledge base. The foundation of the Generative Learning Strategy of teaching emphasised that, the learner is not a passive beneficiary of information rather a learner is an active contributor in the learning process, working to create meaningful understanding of information originated in the immediate environment (Wittrock, 1974).

The literature suggests that activities and steps of Generative Learning Strategy vary. For example, George (2011) noted that Generative Learning activities are divided into two. First, the students are encouraged to construct organisational association such as the title, the concentration, the questions, the objectives, a summary, the graphs, the place, and the main ideas. Second, the students are asked to produce the integrated associations between what they see, hear and learn by creating metaphors for example: the analogies, the interpretations, the paraphrases and the conclusions. Maknun (2015) also noted that there are five steps for the Generative Learning model which are the orientation, the disclosure of ideas, the challenges and reconstruction, implementation and evaluation.

Pappas (2014) described the Generative Learning Strategy as having four main key concepts that instructors can use, depending on the needs of the learners and the teaching and learning materials involved. The four concepts proposed by Pappas (2014) are: recall, integration, organisation and elaboration. In the ***recall***, the learner retrieves information stored in the long term memory to aid learning. This may involve regular repetition of a concept. In the ***integration***, learner continues new information with those already stored in the long term memory to create a new knowledge. This may involve the use of analogies to make concepts clearer. In ***organisation***, the learner re-organises knowledge through critical analysis of concepts. This may facilitate the creation of a list of related concepts. Finally, in ***elaboration***, the learners are taught to connect new knowledge to the existing ones to create an expanded knowledge. This may be done through critiquing an existing knowledge.

Although the body of literature such as George (2011), Pappas (2014) and Maknun (2015) suggested that the activities of Generative Learning Strategy vary, they have the potential to promote the mastery of concepts. This mastery of concept in Generative Learning Strategy could be attributed to intellectual skills which are related to students' cognitive abilities. A student is said to demonstrate cognitive abilities if such a student is able to define concepts, construct the organisational association such as the title, the concentration, the questions, the objectives, a summary, the graphs, the place, and the main ideas. Also, students who have cognitive abilities can produce the integrated associations between what they see, hear and learn by creating the metaphor. The cognitive abilities are associated with Generative Learning Strategy activities as proposed by George (2011).

Statement of the Problem

Teaching and learning approaches continue to change over the decades. This is due to the numerous research works being conducted by educationists. Similarly, the Ghanaian academic curriculum continues to advocate the use of modern approaches to teaching. This emanates from the fact that many Ghanaian teachers appear stagnant with teaching methods that do not facilitate students' learning. This study has identified Generative Learning Strategy as one of the modern approaches that the literature has researched and has touted its potency for improving students' learning and motivation in Physics.

It is against this background that this present study was designed to investigate the effect of Generative Learning Strategy which involves active involvement of learners which has the potential of yielding improved academic achievement in physics. Atsuwe and Anyebe (2016) stated that Generative Learning Strategy is credited with the possession of potentials for allowing the self-efforts and abilities of learners through active processes leading to good academic achievement in Physics.

Purpose of the Study

The purpose of this study was to specifically determine the effects of Generative Learning Strategy on students' academic achievement in Physics and motivation to learn Physics.

Research Questions

This study was guided by the following research questions:

1. What difference exists in the achievement test scores between students instructed using Generative Learning Strategy and

those instructed using lecture method with discussion and demonstration?

2. What are the perceptions of students about their motivation to study Physics, before and after they were instructed with The Generative Learning Strategy?
3. What difference exists between Physics test scores of males and females instructed with the Generative Learning Strategy?
4. What difference exists between Physics test scores of higher-achievers and low-achievers instructed with the Generative Learning Strategy?

Research Hypotheses

From the research questions raised, two hypotheses were stated and tested at 0.05 level of significance.

Ho_1: There is no significant difference in achievement test scores between male and female students instructed using Generative Learning Strategy.

Ho_2: There is no significant difference in achievement test scores between high and low-ability students in the Generative Learning Strategy group.

Methodology

Design of the Study

The design used in this study was the pretest-intervention-posttest, non-equivalent comparison-group design. This design was selected because it aided the establishment of cause and effect between the independent variables and the dependent variables. Table 1 gives step-by-step implementation of the intervention among the two groups.

Table 1: Research design

Groups	Pretest	Treatment	Posttest
	01	**0X**	**03**
Experimental (n_1= 48)	Selected topics in physics based on C.o.E* Syllabus	Generative learning Activities (Independent variable)	-Achievement -Motivation, Sex and ability difference (Dependent variable)
	02	--	--**04**
Control (n_2= 50)	Selected topics in physics based on C o E* Syllabus	Lecture, discussion demonstration and (Independent variable)	-Achievement (Dependent variable)

*College of Education

Population and Sample of the Study

A total of 98 males and females composed of high-achievers and low-achievers in physics were used for the study. The respondents were randomly selected from Berekum College of Education level hundred students of 2017/18 academic year group. The respondents were between the ages of 19 and 35 years and were grouped into two different classes. The first class (A) constituted the experimental (n_1=48) whereas the second class (B) constituted the control (n_2= 50).

The respondents were divided into the groups according to their scores in the baseline ability assessment test in Physics concepts. Guided by the baseline assessment scores, students were randomly and proportionately assigned to the experimental and control group. As both the experimental group and control group took the same pretest and posttest and the intervention covered the same time period for all subjects, testing, instrumentation, maturation, and mortality are not internal-validity problems. Also, the same researcher taught both the experimental and control groups on different days Wednesday and Thursday respectively, as a result history is not a problem in this study, since differences among teachers cannot systematically influence post-test results.

Research Instruments

Two main research instruments, Multiple Choice Item (**MCI**) and Motivation Perception Survey on Generative Learning (**MPSGL**) were used for the study. These instruments were prepared by the researcher and were field pilot-tested to determine their reliability and validity.

MCI: The test consisted of 25 multiple choice items in selected concepts (force, motion, and machines) in Physics based on the Colleges of Education syllabus in Ghana. This was used to test students' knowledge in Physics before and after the introduction of the intervention. The test items were validated by two Science educators at Berekum College of Education Science Department. Test retest reliability analysis revealed Cronbach's alpha reliability coefficients of .76. This value indicated a very satisfactory level of the test items.

In order to differentiate between higher-achievers and lower-achievers after the exposure to Generative Learning activities, the test items were constructed by adopting a discrimination power (ability of the test to discriminate between higher and lower achievers). A discrimination power of above .20 was considered as being acceptable. According to Ebel and Frisbee (1986), as a rule of thumb, test items with discrimination power below .20 were removed and reconstructed. Also, items with discrimination index of .04 and greater are very good items, .03 to .39 are reasonably good but possibly subject to improvement. The authors added that test items with discrimination index between .02 to.29 are marginal items and need some revision. Below .19 are considered poor items and need major revision or should be eliminated. Consequentially, items with discrimination index levels below and above the specified range stated by Ebel and Frisbee were removed and reconstructed.

MPSGL: MPSGL instrument requires respondents to rate their level of agreement with statements on a 5-point Likert scale ranging from strongly disagree to strongly agree on the motivation perception survey before and after exposure to the intervention. A reliability test was carried out to determine the internal consistency of the items in the questionnaire by using Cronbach's alpha reliability test. Cronbach's alpha coefficient was .79. Themes in the **MPSGL** instrument included: enthusiasm to learning, understanding of concepts, recall of concepts, and integration of concepts.

Intervention Phases

The two groups (experimental and control) were instructed by the researcher on different days for the seven weeks of the interventional phase. To ensure uniformity and consistency in the teaching and learning process, the researcher used same teaching notes, same exercises and assignments for the two groups. The control group was instructed by using lecture, demonstrations, and discussions with the students. The experimental group was instructed using the Generative Learning activities as highlighted in Table 2 in accordance to the literature searched (Pappas, 2014).

Table 2: Intervention Phases for the Experimental Group

Phase	Strategy	Teacher Learner Activities
1: Introduction	Recall	Teacher assessed students prior information stored related to the current topic that has been already acquired using an advanced organiser.
2: Development	Integration	Through class discussion, demonstration, and lecture, teacher assisted students in making connections to the prior knowledge and the current knowledge structure by using metaphors, paraphrasing, etc.
	Organisation	Through outlines, summaries and concepts mapping, teacher assisted students with imposing on content learnt.
	Elaboration	Teacher assisted students with elaborating on information by making connection to real examples by identifying examples, predicting results and giving examples.
3: Assessment		Teacher gave end of lessons' assignments and quizzes, to evaluate the impact of the Generative Learning activities
4: Conclusion		Teacher concluded the lesson by summing up the main points, reflecting on the lesson using recall, integration, organization and elaboration strategies.

Data Analysis

The data relating to the research questions were analysed using descriptive statistics such as means and standard deviation. However, inferential statistics such as t-test was used to test the hypotheses at significant level of .05.

Effect size analysis was also used to investigate how the two different types of teaching strategies affected students' academic achievement. According to the definition of Cohen as cited by Kia-Ti and Tzu-Hua (2012), Cohen's *d* less than .2 means 'small' effect size, between .2 and .5 means 'small to middle' effect size, between .5 and .8 means 'middle to large' effect size, while larger than .8 means 'larger' effect size.

Results

Research Question One: *What difference exists in the achievement test scores between students instructed using Generative Learning Strategy and those instructed using lecture method fused with discussion and demonstration?*

To find out the difference in the achievement of students instructed using Generative Learning Strategy and students instructed using lecture method fused with discussion and demonstration, descriptive statistics were computed on the results of MCI and used to determine the difference in the achievement between the experimental group and the control group. Table 3 shows the mean, standard deviation and mean gains of the experimental group and the control group in the MCI conducted before and after the introduction of the interventions.

Table 3: Pre-Test and Post-Test Descriptive Analysis for the Experimental and Control Groups

Groups	N	Pretest Mean[a]	Posttest Mean[b]	Mean Gain [c = b-a]
Experimental	48	11.83(3.92)*	16.64(2.53)	4.81
Control	50	11.53(3.68)	14.67(2.93)	3.14

*Standard deviation in parentheses

Table 3 shows that the experimental group pre-test and post-test mean scores were 11.83 (SD = 3.92) and 16.64 (SD = 2.53) respectively. Also, the control group had pre-test and post-test scores of 11.53 (3.68) and 14.67 (SD = 2.93) respectively. The mean gain for the experimental group was 4.81 whereas the mean gain for the control group was 3.14. These results as presented in Table 3 revealed that students instructed using Generative Learning Strategy performed better in the MCI than those instructed using lecture method fused with discussion and demonstration.

To further estimate the extent of difference between the two groups, an effect size analysis was carried out using Cohen's (*d*) index formula (See Appendix A). This involves comparing the mean scores of the two groups and dividing them by their standard deviation. The results of the magnitude of the effect size analysis are presented in Table 4.

Table 3: Pre-Test and Post-Test Descriptive Analysis for the Experimental and Control Groups

Groups	N	Pretest Mean[a]	Posttest Mean[b]	Mean Gain[c=b-a]
Experimental	48	11.83(3.92)*	16.64(2.53)	4.81
Control	50	11.53(3.68)	14.67(2.93)	3.14

*Standard deviation in parentheses

It can be inferred from Table 4 that the effect size of the experimental group was 1.5. This represents large effect size in accordance to Cohen's *d* indexes. Also, effect size estimated for the control group was 0.9. This also represents large effect size. However, the effect size of the experimental group is relatively greater than the control group.

Research Question Two: *What are the perceptions of students about their motivation to study physics, before and after they were instructed with The Generative Learning Strategy?*

The effects of using Generative Learning Strategy on students' motivation to learning physics were examined through the analysis of the before and after motivation perception survey of Generative Learning Strategy. Table 5 shows the criteria used to interpret the mean score for MPSGL whereas Table 6 shows the means scores for each item.

Table 5: Level of Interpretation of Mean Score

Mean Score	Level
0.01-1.00	Strongly Disagree
1.10-2.00	Disagree
2.01-3.00	Neutral
3.01-4.00	Agree
4.01-5.00	Strongly Agree

Table 6: Descriptive Analysis of Pre and Post MPSGL

S/N	MPSGL	Pre		Post	
		M	*SD*	*M*	*SD*
1	I enjoy Physics lesson	2.70	.78	3.20	.64
2	Physics is difficult	2.01	.86	2.96	.68
3	I like to learn Physics topics that are more challenging	2.65	.60	3.33	.74
4	I contribute constructively during Physics lessons	2.55	.59	3.01	.87
5	I feel I am achieving the learning outcomes in Physics	1.99	.46	3.25	.76
6	Generative Learning activities arouse students' interest in Learning Physics	---*	---	3.98	.59
7	Generative Learning activities motivate students to study Physics topics that are more challenging	---*	---	3.89	.60

8	Generative learning activities help students to retain Physics concepts	---*	---	3.79	.89

**Items 6-7 were not assessed in the pre-perception motivation surveys*

The results in Table 6 with reference to Table 5 suggest that after using Generative Learning Strategy with the experimental group, more students enjoyed physics lessons with mean score of 3.2 (SD=.78) as against mean score of 2.7 (.64) before using Generative Learning Strategy. The analysis also revealed that students' ability to solve more challenging physics questions increased from mean score of 2.65 (SD=.60) to mean score of 3.33(SD=.74) after exposure to Generative Learning Strategy. The results also show that students relatively contributed constructively in the Physics lessons using Generative Learning Strategy with mean score of 3.01 (SD=.59) as against mean score of 2.55 (SD=.87). The results also show that students perceived that they could achieve their learning goals in Physics if they are instructed using Generative Learning Strategies. However, responses on item-2[Post 2.96 (SD=.68); Pre 2.01(SD=.86)] suggest that, students' perception that Physics is difficult still persists after the introduction of the Generative Learning Strategy.

The results as indicated in Table 6 with reference to Table 5 also suggested that students' interest, motivation and ability to retain learnt Physics concepts were enhanced after exposure to Generative Learning Strategy with relatively high mean scores of 3.98 (SD=.59), 3.89 (SD=.60) and 3.79 (SD=.89) respectively. These high means scores suggest an enhanced motivation after students' exposure to Generative Learning Strategies.

Research Question Three: *What difference exists between physics test scores of males and females instructed with the Generative Learning Strategy?*

To find out the difference in the physics test scores of male and female students in the experimental group, descriptive statistics were computed on the MCI results. Table 7 shows the mean, standard deviation and mean gains of males and females results on the MCI conducted before and after the introduction of the interventions.

Table 7: Gender Descriptive Analysis for the Generative Learning Group

Sex	N	Pretest Mean[a]	Posttest Mean[b]	Mean Gain C=b-a
Males	27	11.98(2.85)*	16.11(2.85)	4.81
Females	21	10.63(3.68)	15.05(1.88)	4.42

* Standard deviation in parentheses

Table 7 shows that the male students pre-test and post-test mean scores were 11.98 (SD = 2.85) and 16.11 (SD = 2.85) respectively. Also, the female students had pre-test and post-test scores of 10.63 (SD=3.68) and 15.05 (SD = 1.88) respectively. The mean gain for the male students was 4.81 whereas the mean gain for the female students was 4.42. These results as presented in Table 7 revealed that male students instructed using Generative Learning Strategy slightly performed better in the MCI than their female counterparts.

Testing of Hypothesis with Respect to Research Question Three

To determine whether the difference in the performance between the experimental group and the control group was statistically significant, research question three was formulated into a null hypothesis and tested. It was hypothesised that:

H_{01}: *There is no significant difference in achievement test scores between male and female students instructed using Generative Learning Strategy*

To find out if a significant difference existed between males and females' achievement in the MCI after using Generative Learning

Strategy, an independent samples t-test was performed. The results are presented in Table 8.

Table 8: Gender Inferential Mean Score Statistics for the Generative Learning Group

Gender	N	Mean	SD	df	t-value	p-value
Males	27	16.11	1.30	46	2.01	.08
Females	21	15.05	1.19			

It can be inferred from Table 8 that there is no significant difference between the results of the MCI for males (M =16.11, SD = 1.30) and those of females (M=15.05, SD= 1.19). [t = (46) 2.01, p= .08]. Hence the null hypothesis was retained. However, the result as presented in Table 8 shows that the male students slightly performed better than their female counterparts in the MCI.

Research Question Four: *What difference exists between physics test scores of higher-achievers and low-achievers instructed with the Generative Learning Strategy?*

To find out the difference in the achievement of high and low-ability students instructed using Generative Learning Strategy in the experimental group, descriptive statistics were computed and used to determine the difference in the achievement between high and low-ability students in the experimental group. Table 9 shows the mean and standard deviation of males and females' results of the MCI conducted before and after the introduction of Generative Learning Strategy.

Table 9: Comparison of Achievement Test Scores of High and Low-Ability Students after Exposure to Generative Learning Strategy

Groups	N	Mean	Std. Dev
Higher- Abilities	22		
Pre-test		14.83	3.92
Post-test		16.87	2.53
Lower-Abilities	26		
Pre-test		08.53	3.68
Posttest		15.67	2.93

After using Generative Learning Strategy in teaching the experimental group, the higher-ability group in the experimental group scored higher marks (M =16.87, SD =2.53) on the post-achievement test scores compared to the low-ability group test scores in the experimental group (M=15.67, SD =2.93).

Testing of Hypothesis with Respect to Research Question Four

To determine whether the difference in the achievement between the high-ability and the low-ability in the experimental group was statistically significant, research question four was formulated into a null hypothesis and tested. It was hypothesised that:

Ho_2: *There is no significant difference in achievement test scores between high-achievers and low-achievers after instructing students using Generative Learning Strategy.*

To find out if significant difference existed between high and a low-ability group after instructing students using Generative Learning Strategy, independent samples t-test was performed. It can be inferred from Table 10 that there was no significant difference between the performance of high-ability (M= 16.76, SD = 2.53) and low-ability (M = 15.67, SD = 2.93) groups [t (46) = -.24, p = .81]. Therefore, the null hypothesis was retained.

Table 10: Inferential Statistics for the High and Low-Ability Groups in the Generative Learning Strategy

Group	N	*Mean*	*SD*	*Df*	*t-value*	*p-value*
High-achievers	22	16.76	2.53	46	-.24	.81
Low-achievers	26	15.67	2.93			

Discussion

The findings of this study have demonstrated the effectiveness of Generative Learning Strategy in the teaching and Learning of physics lessons. This study is significant in that it demonstrates the effects of Generative Learning Strategy on students' achievement and motivation in one single study. Again, the study compared how sex and ability (i.e. high and low-achievers) variations influence students' scores in Generative Learning Strategy lessons.

One major finding of this study is that students instructed using the Generative Learning Strategy scored higher marks in the MCI achievement test used than those instructed using lecture teaching method fused with discussion and demonstration. Specifically, using Magnusson (2014) standardised interpretation, 1.5 Cohen *d* obtained for the experimental group means that the mean performance of about 92% of the students instructed using Generative Learning Strategy would be above those instructed using lecture fused with the discussion and demonstration. Moreover, Magnusson's (2014) interpretation means that there is about 84% chance that a student picked at random from the experimental group will have higher score than a student picked at random from the control group. This shows superiority of using Generative Learning Strategy over the lecture fused with discussion and demonstration.

The students in the Generative Learning group were found to exhibit improved motivation towards the learning of physics, as measured by their motivational perception scores, using the **MPSGL**. This seems to agree with the general notion that individuals can change their motivation and disposition about subjects through interactive learning strategy. For example, Mwanmewenda (2010) noted that the extent to which learners learn depends on their level of motivation which can be stimulated by the nature of the learning environment and the teaching Strategy utilised by the teacher.

The relative higher levels of motivation by students in the Generative Learning class may also be explained, at least in part, by the fact that student-centered lessons promote better understanding than teacher-centered lessons. For example, Felder and Brent (2007) note that student-centered methods have repeatedly been shown to be superior to the traditional teacher-centered approaches to instruction. They conclude that student-centered lessons promote short-term mastery, long-term retention, or depth of understanding of course material, acquisition of critical thinking or creative problem-solving skills, formation of positive attitudes toward the subject being instructed, or level of confidence in knowledge or skills.

In the current study, neither achievement results were affected by sex or ability. For example, all students, irrespective of their sexes, benefited in about the same margin from the use of the Generative Learning Strategy. This may be the reason why no significant difference was found in achievement by gender in the use of Generative Learning Strategy. However, the results revealed that the males slightly out-performed their females' counterparts. Also, the results revealed that there was no significant difference between the high-achiever and low-achiever students with regard to the use of Generative Learning Strategy.

The result of this current study supports the findings of Atsuwe and Anyebe (2016) that Generative Learning Strategy was effective in enhancing students' academic performance in Physics. However, on the basis of gender in relation to Generative Learning Strategy utilisation in classrooms, the current findings of this study are contrary to the conclusion drawn by Atsuwe and Anyebe that, there existe a difference in the academic performance between male and female students. Also, the results of this study support research findings (Joyce & Calhoun, 2000; Maknun, 2015) that Generative Learning Strategy fosters students' academic achievement in science-related subjects.

Conclusion

Based on the findings of the current study, it is significant to conclude that students perform better in Physics concepts when instructed using the Generative Learning Strategy compared to using lecture with discussion and demonstration. Also, the study shows that there is no significant difference in the academic achievement between males and females and ability groups (higher and lower) achievers after being taught with the Generative Learning Strategy.

Recommendations

Based on the findings of the study and conclusions drawn, some recommendations are made.

1. Physics teachers should use the Generative Learning Strategy to teach Physics lesson so as to improve students' academic performance.
2. Students should be empowered by their teachers to assume responsibility for their own learning while the teacher becomes a facilitator or a coach in the learning process. This can be done when teachers adopt instructional Strategy which is student-centered in nature such as the Generative Learning Strategy.
3. In-service training in the form of workshops, conferences and seminars should be organized by College managements to prepare teachers to incorporate Generative Learning Strategy in the teaching and learning of physics at the Colleges of Education in Ghana.

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APPENDIX A

Cohen's d formula

$$d = \frac{M_1 - M_2}{\sqrt{\frac{S_1^2 + S_2^2}{2}}}$$

M_1	=	Mean of post- test
M_2	=	Mean of pre-test
S_2^2	=	Standard deviation of post- test
S_1^2	=	Standard deviation of pre-test
d	=	Calculated Cohen's d