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Generative Learning Strategy: Physics Intervention Strategy For Improved Academic Achievement And Motivation By Gender

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***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 subjects. The subjects were composed of males, females, high achievers and low achievers in physics scores of 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 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 used to answer the research questions, while t-test was also used to test the hypotheses. The results indicated that students instructed using Generative Learning Strategy performed better in the MCI test instrument than those instructed using lecture method fused with demonstration and discussion. Also the results suggest that Generative Learning Strategy increases 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. Based on the results obtained, it was, therefore, suggested that, physics teachers at the Colleges of Education should be encouraged to use Generative Learning Strategy to teach physics to sustain students' academic achievement in physics' concepts and motivation.*

***Keywords:** Generative Learning, Achievement, Motivation and Gender*

I. INTRODUCTION

Some researchers in recent years have lighted the declined 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 been boring, irrelevant and too abstract. Literatures (Sillito & Mackinnon, 2000; Boyes & Dickson, 2003) also noted that the study of physics in schools and universities is spiraling into decline as many students believe it is too difficult. Consequently, this has negative effect on the academic achievement of physics students.

The kind of learning environment, interaction, and teaching methods utilized 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, utilization of appropriate instructional methods could be beneficial to halt this decline. The instructional method which is right for a particular lesson depends on many 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 interest 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).

A review of 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 utilized by the teacher (Mwanmwenda, 2010). He further added that the teacher's role is to influence

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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 assertion would be useful if teachers or instructors use students-centered teaching methods other than teacher-centered methods.

In the teacher-centered instructed 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 chalkboard. In teacher-centered lessons, students take notes and after the teacher's explanations, the concepts are discussed through teacher-directed questions. Consequently, students in this learning situation are likely to be passive learners instead of active learners.

According to Pickering and Pollock (2001), active or participatory learning by the students is the effective, efficient, and superior instruction for teaching and learning. Pickering and Pollock assertion was collaborated 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 of Generative Learning, the students are demanded to prepare themselves mentally for understanding the material information instructed. This implies that in the Generative Learning Strategy, the active students take greater part of 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 individualized 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 individual students' long term memory which becomes component of our knowledge base. The foundation of the Generative Learning Strategy of teaching emphasized 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).

Literatures suggest that, activities and steps of Generative Learning Strategy vary. For example, George (2011) noted that, Generative Learning activity is divided into two as follows. First, the students are encouraged to construct organizational association such 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 examples: the analogies, the interpretations, the paraphrases and the conclusions. Maknun (2015) on the contrary 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 the evaluation.

Pappas (2014) also described the Generative Learning Strategy as having four main key concepts that instructors can involve depending on the needs of the learners and the teaching and learning materials involved. Pappas four main concepts of Generative Learning Model are examined as follows:

RECALL: This occurs when the learner accesses information stored in his/her long term memory to learn a content that is based upon facts by using information that he/she has already acquired. An example of the recall activity is having the learner repeat information or review the concept until the concept is fully grasped by the learner.

INTEGRATION: This occurs when the learner integrates new information with knowledge already collected and stored in the brain. The aim is to alter already stored information in a form which the learner can more easily remember and access it later on. An example of integration is creating analogies to explain knowledge already collected and stored in the brain.

ORGANIZATION: This involves learners linking knowledge they have already collected to new concepts in an effective way. An example of organization involves learners creating lists or analysing the main points of a specific concept.

ELABORATION: This involves the teacher encouraging the learner to connect and add new concepts to information they have already collected by analyzing the ideas. An example of elaboration involves expanding upon thought and visual representation of mental images.

Although literatures such as George (2011), Pappas (2014) and Maknun (2015) suggested that the activities of Generative Learning Strategy vary, however, its ability to promote the mastery of concepts is not in question. 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 organizational association such the title, the concentration, the questions, the objectives, a summary, the graphs, the place, and the main ideas. Also, the students who have cognitive abilities can produce the integrated associations between what they see, hear and learn by creating the metaphors for example. All these cognitive abilities are associated with Generative Learning Strategy activities as highlighted by George (2011).

STATEMENT OF THE PROBLEM

Physics can be recognised as an important academic subject to every society. The reason for this is due to the fundamental role it plays in modern scientific and technological developments. Despite this, the number of students studying physics has declined (Ho & Boo, 2007). In Ghana for example, students' academic achievement in physics at the national and internal examinations has been relatively low. The executive summary of the T.I.M.S.S. for 2007 by Anamuah-Mensah, Mireku and Ghartey-Ampiah (2008) noted the following in the study of science in Ghana:

- ✓ The overall performance of the Ghanaian JHS2 students on the science test was very low.
- ✓ The mean score of 276 in physics was the least performed among the Ghanaian JHS2 students in all the domains.

The abysmal performance in physics as highlighted by Anamuah-Mensah et al. is not limited to JHS physics studies in Ghana only. For example, a field survey conducted by the Researcher showed that most of the students' of Berekum College of Education fear the physics components of all the Integrated Science courses. This has negative effect on the teaching and learning of physics concepts in the College.

To improve students' academic achievement and interest in the study of physics, students should be guided to construct their own knowledge and ideas in learning because they are the owners of their own learning and potential benefit of their knowledge. This suggests that, continuous use of teacher-centered or teacher dominated strategies would yield nothing but learning by rote, consequently making it difficult for students to recall, integrate, organize and elaborate on learnt physics concepts from memories.

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. Literature 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, therefore, was to specifically determine, among others, the effects of Generative Learning Strategy on students' academic achievement in physics, motivation to learn physics and also test if Generative Learning Strategy is ability (i.e. higher and low achievers) and gender dependent.

RESEARCH QUESTIONS

This study was guided by the following research questions:

- ✓ Is there any difference in achievement test scores between students instructed using Generative Learning Strategy and those instructed using lecture method fused with discussion and demonstration?
- ✓ Is there any difference in motivational perception survey scores between students instructed using Generative Learning Strategy before and after exposure to Generative Learning Strategy?
- ✓ What difference exists between male and female students' achievement test scores after the exposure to Generative Learning Strategy?
- ✓ What difference exists between higher-achievers and low-achievers test scores after instructing students using 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.

II. 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 variable and the dependent variables. Table 1 gives step-by-step implementation of the intervention among the two groups.

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

College of Education

Table 1: Research design

POPULATION AND SAMPLE OF THE STUDY

A total of 98 males, females, high-achievers and low-achievers in physics were used for the study. The subjects were randomly selected from Berekum College of Education level hundred students of 2017/18 academic year group. The subjects were between the ages of 19 and 37 years and were composed 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).

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The subjects were divided into the groups according to their scores in the baseline ability assessment test in physics concepts. Students in the middle ability group in accordance to baseline assessment test were not used for the study because of their ability to become either high or low achievers in the process of intervention. Guided by the ability scores, students were randomly and proportionately assigned to the experimental and control group classes.

As both the experimental group and control group took the same pretest (before the intervention) and posttest (after the intervention), 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 alone taught both the males and females, as a result history is not a problem in this study, since differences among teachers cannot systematically influence posttest 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 assess the reliability and validity of the instruments.

MCI: The test consisted of 25 multiple choice items in selected concepts in physics based on the Colleges of Education syllabus in Ghana. This was used to test students' knowledge of 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 Alpha reliability coefficients of .76. This value indicated a very satisfactory level of reliability.

In other to differentiate between higher-achievers and lower-achievers after the exposure to Generative Learning activities, the 25 multiple choice items were constructed by adopting a discrimination power (ability of the test to discriminate between higher and lower achievers) of .20 and above 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. They 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. Examples of items in the MPSGL instrument included: enthusiasm to Learning, understanding of concepts, recall of concepts, and integration of concepts.

INTERVENTION PHASES

The two groups were instructed by the researcher at different days for the seven weeks of the interventional phase. To ensure uniformity and consistency in the teaching and learning process, the research used same teaching notes, same exercises and assignments for the two groups. The control group was instructed by using lecture fused with 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.

PHASE	STRATEGY	TEACHER LEARNER ACTIVITIES
1: Introduction	*Recall*	Teacher accessed students prior information stored related to the current topic that has been already acquired using an advanced organizers
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.
	Organization	Through outlines, summaries and concepts mapping, teacher assisted students with imposing an 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

Table 2: Intervention Phases for the Experimental Group

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 (1988), 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.

III. RESULTS

RESEARCH QUESTION ONE: Is there any difference in 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.

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 parenthesis*

Table 3: Pretest and Posttest Descriptive Analysis for the

Table 3 shows that the experimental group pretest and posttest mean scores were 11.83 (SD = 3.92) and 16.64 (SD = 2.53) respectively. Also, the control group had pretest and posttest 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 were presented in Table 4.

Groups	Posttest Mean(M_2)	Pretest Mean(M_1)	Mean Diff. (M_2-M_1)	Effect Size (*d*)
Experimental	16.64(2.53)*	11.83(3.92)	4.81	*1.5*
Control	14.64(2.93)	11.83(3.68)	3.14	*0.9*

** Standard deviation in parenthesis*

Table 4: Magnitude of Effect for the Treatments

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.

RESEARCH QUESTION TWO: Is there any difference in motivational perception survey scores between students instructed using Generative Learning Strategy before and after exposure to 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. The results are presented in Table 5 with graphical representation in Figure 1.

S/N	MPSGL	Pre *M*	Pre *SD*	Post *M*	Post *SD*
1	*I enjoy physics lesson*	2.70	.78	3.20	.64
2	*Physics is difficult*	2.96	.68	2.01	.86
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*	---*	---	3.98	.59
	in Learning physics				
7	*Generative Learning activities motivate students to*	---*	---	3.89	.60
	study physics topics that are more challenging				
8	*Generative learning activities help students to retain*	---*	---	3.79	.89
	physics concepts				

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

Table 5: Descriptive Analysis of Pre and Post MPSGL

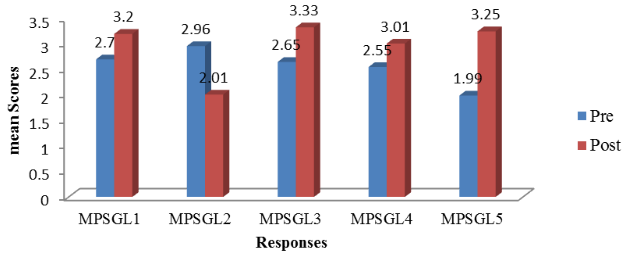

Figure 1: Pre and Post Motivation Survey on Generative Learning

Table 5 and Figure 1 suggests 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 2.7(.64) before using Generative Learning Strategy. Also, students perception that physics is difficult reduced from mean score of 2.96(SD=.68) to 2.01(SD=.86). The analysis revealed that students ability to solve more challenging physics questions increased with mean score of 2.65(SD=.60) to 3.33(SD=.74) after exposure to Generative Learning Strategy. The results also show that, students contributed constructively in the physics lessons after using Generative Learning Strategy with mean score of 3.01(SD=.59) as against 2.55(SD=.87). The results also show that, students perceived that they could achieved their learning goals in physics if they are instructed using Generative Learning Strategies.

The results as indicated in Table 5 and Figure 1 also suggested that students' interest, motivation and ability to retain learnt physics concepts were enhanced after exposure to Generative Learning Strategy with mean scores of 3.98(SD=.59), 3.89(SD=.60) and 3.79(SD=.89) respectively. These means scores are above the hypothetical means score of three (3.0), suggesting an enhanced motivation after students' exposure to Generative Learning Strategies.

RESEARCH QUESTION THREE: What difference exist between male and female students achievement test scores after exposure to Generative Learning Strategy?

To find out the difference in the achievement of male and female students instructed using Generative Learning Strategy in the experimental group, descriptive statistics were computed on the MCI results. Table 6 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.

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 parenthesis*

Table 6: Gender Descriptive Analysis for the Generative

Table 6 shows that the male students pretest and posttest mean scores were 11.98 (SD = 2.85) and 16.11 (SD = 2.85) respectively. Also, the female students had pretest and posttest 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 6 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 were 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 significant after using Generative Learning Strategy, an independent sample t-test was performed. The results are presented in Table 7.

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			

**Not Significant at p > .05*

Table 7: Gender Inferential Mean Score Statistics for the

It can be inferred from Table 7 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 7 shows that the male students slightly performed better than their female counterparts in the MCI.

RESEARCH QUESTION FOUR: What difference exists between higher-achievers and low-achievers test scores after instructed students using 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 8 shows the mean and standard deviation of males and females' results of the MCI conducted before and after the introduction of Generative Learning Strategy.

Learning Strategy

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

Table 8: Comparison of Achievement Test Scores of High and Low-Ability Students after Exposure to Generative

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) as shown in Table 8.

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 were 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 instructed students using Generative Learning Strategy.

To find out if significant difference existed between high and low-ability groups after instructing students using Generative Learning Strategy, independent samples t-test were performed. It can be inferred from Table 9 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.

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			

**Not Significant at p > .05*

Table 9: Inferential Statistics for the High and Low-Ability

IV. 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 demonstrated 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 scores in the MCI achievement test used than those instructed using lecture teaching method fused with discussion and demonstration. Specifically, using Magnusson (2014) interpretation, 1.5 Cohen *d* obtained for the experimental group means that, about 92% of the students instructed using Generative Learning Strategy mean performance would be above student instructed using lecture fused with the discussion and demonstration. Moreover, 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 utilized 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) noted that, student-centered methods have repeatedly been shown to be superior to the traditional teacher-centered approaches to instruction. They concluded 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 this 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 perhaps, may be the reason why no significant difference was found in achievement by gender on the use of Generative Learning Strategy. However, the results revealed that the males slightly out performed their females' counterpart. Also, the results revealed that, there was no significant difference between the high-achiever and low-achiever students with regard to the used of Generative Learning Strategy.

The result of this current study supports Atsuwe and Anyebe (2016) findings 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 utilization in classrooms, the current findings of this study contradict the conclusion by Atsuwe and Anyebe that, although, there existed a difference in the academic performance between male and female students, which was in favour of the females, the t-test analysis showed that the difference was insignificant. Also, the results of this study support research findings of (Joyce & Calhoun, 2000; Maknun, 2015) that Generative Learning Strategy foster students' academic achievement in science related subjects.

V. CONCLUSION

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

VI. RECOMMENDATIONS

Based on the major findings of the study and conclusions drawn, some recommendations are made here for consideration.

- ✓ Physics teachers should develop interest in the use of Generative Learning Strategy. They should develop the Generative Learning Strategy skills and knowledge in order to enhance their use in Colleges of Education and break from the regular believes underlying the teaching and Learning of physics.
- ✓ Students should be empowered by their teachers to assume responsibility for their own studies 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.
- ✓ 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 College of Education in Ghana.

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