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# The Effect of Performance Assessment-Driven Instruction on the Attitude and Achievement of Senior High School Students in Mathematics in Cape Coast Metropolis, Ghana

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**Abstract**
The study was a quasi-experimental research project conducted to investigate the effect of performance assessment-driven instructions on the attitude and achievement in mathematics of senior high school students in Ghana at Ghana National College in Cape Coast. Two Form 1 science classes were used for the study and were assigned as experimental and control groups. These two classes were randomly chosen for the study. The experimental group consisted of forty-two students and control group forty students. Data was collected through the use of an open ended test in mathematics and a questionnaire on students' attitudes to mathematics. The questionnaire contained 15 Likert-type questions. The independent samples t-test was used to find the differences between the groups. The experimental group differed significantly on the post-test scores from the control group. This study identified that PA-driven instruction improved students' problem-solving abilities and increased student confidence in doing mathematics because they felt more competent in working mathematical problems.The study also explored students' attitude to mathematics through the use of a Likert-type questionnaire. The findings showed that students' attitudes toward mathematics were generally positive. It is recommended that Ghana Education Service should organise in-service training for mathematics teachers on the use of PA-driven instructions and mathematics teachers should also integrate performance assessment-based tasks in their students' exercises.
**Keywords:** Performance assessment, Attitude

## 1. Introduction

The knowledge of mathematics is an essential tool in our society (Baroody, 1987). It is a tool that can be used in our daily life to overcome the difficulties faced (Bishop, 1996). Due to this mathematics has been considered as one of the most important core subject in a school curriculum. Attitude towards mathematics plays a crucial role in the teaching and learning processes of mathematics. It affects students' achievement in mathematics. The teaching method and the mode of assessment affect the attitudes towards mathematics. Usually, the way that mathematics is represented in the classroom and perceived by students, even when teachers believe they are presenting it in authentic and context-dependent way stands to alienate many students from mathematics (Barton, 2000; Furinghetti and Pehkonen, 2002). Higgins (1997) found that middle school students in the United States trained in problem-solving techniques following National Council of Teachers of Mathematics (NCTM) recommendations had more positive attitudes toward mathematics and were more persistent in seeking solutions than were students in more traditional classrooms.

This suggests a need to depart from the traditional approach of teaching mathematics to performance assessment-driven instruction (PA-driven instruction). The traditional approach of mathematics instruction consists almost entirely of teachers directing students to memorise presented facts or apply formulae, algorithms, or procedures without attention to why or when it makes sense to do so. In recent years research has consistently confirmed that isolated learning is not retained (Hiebert, 2003). Mathematics as a subject is a closely-knit system of ideas, principles and processes. Connections among concepts and principles should be established so that learning arithmetic is less a challenge to the students' memory and more a challenge to his or her intelligence. When students learn a procedure without meaning they will have difficulty knowing when to use it, remembering how to use it, applying it in new situations and judging if the results are reasonable.

By contrast, in PA-driven instruction Battista (1994) envisioned all students as having numerous and varied interrelated experiences that allow them to: (a) solve complex problems; (b) read, write, and discuss mathematical concepts; (c) conjecture, test, and build arguments; (d) value mathematical and scientific enterprises; and (e) guess and make errors so that students can gain confidence in their own mathematical' actions. At the heart of this reform is that mathematical content, activities, teaching, and learning are no longer based on the view of students as recipients of knowledge transmitted directly from the teacher. Instead, students are seen as possessing prior knowledge and intuitions that shape what they see, hear, and understand (NRC, 1989, 1990; Resnick, 1987).

Nitko (2000) defined performance assessment as a learning target which requires students to apply their knowledge and skills from several areas in order to complete an activity or a task. He further explained that

performance assessment is made up of:
(1) a hands-on task given to a student and
(2) clearly defined criteria to evaluate how well the student achieved the application specified by the learning target.

Traditional assessment (TA) refers to multiple-choice tests, fill-in-the-blanks (supply type), true-false, matching, short-answer type and the like. Students typically select an answer or recall information to complete the assessment. These tests may be commercially available or teacher-made. Performance assessments call upon the examinee to demonstrate specific skills and competencies whilst traditional assessment requires the examinee to recall facts to help select an answer from a set of options.

PA-driven instruction is the kind of teaching which ensures that the learners apply their relevant previous knowledge and abilities to solve open-ended mathematics problems with the teacher as a facilitator.

Here students demonstrate proficiency in solving mathematical problems. Performance assessments, therefore, perfectly combine the use of formative and summative assessments effectively. When evaluation is focused on the process rather than the product, it emphasises the elimination of errors (Turner et al., 1998). This also encourages social comparison (Anderman and Young, 1994), and finally leads to the establishment of a performance-focused climate (Ames, 1992).

The multiple-choice type test which enjoys a lot of usage in assessing students' performance is unable to test students on higher order instructional processes such as analysis, synthesis and evaluation. One reason is that, they are difficult to construct and teachers possess limited skills in constructing higher order objective test items. The true/false and matching type of questions do not also help in assessing higher-order behaviours and solving complex problems (Etsey, 2005).

Barth and Mitchell (1992) maintained that multiple-choice, norm-referenced testing "…corrupts teaching because it essentially makes students passive because, they do not construct an answer but select" (p.14). According to Mitchell (1995), performance assessments imply "…. active student production of evidence of learning – not multiple-choice, which is essentially passive selection among pre-constructed answers" (p. 2). This type of assessment provides teachers with information about how a child understands and applies knowledge. Performance assessments "represent a set of strategies for the...application of knowledge, skills, and work habits through the performance of tasks that are meaningful and engaging to students" (Hibbard, 1996, p. 5). Students' line of reasoning could help improve the instructional process.

Conventional assessment of student achievement historically has focused on the reproduction of factual and procedural knowledge from students (Moss et al, 2006). The items on such assessments typically measure recall of discrete facts, retrieval of given information, and application of routine computational formulas or procedures (Newmann et al., 1998). But while 'snapshot' conventional assessment results give a partial picture of students' performance at a given moment (Rochex, 2006), performance assessment depicts a comprehensive view of the student's performance at a given time.

Due to the important role assessment plays in the teaching and learning process and besides the several deficiencies in the various test formats, educators have constantly been looking out for the best ways of assessing students. For these reasons many educational practitioners have advocated for the use of performance assessment.

Performance assessment is a type of assessment which requires students to demonstrate that they have mastered specific skills and competencies by performing an activity to reveal what they are capable of doing. Performance assessment is, therefore, a clear departure from the traditional test items because, in performance assessment, students are required to perform a task rather than select an answer from a ready–made list; it offers students the opportunity to apply their knowledge and skills from several areas to demonstrate that they are capable of reaching a learning target and coming up with their own solution. Performance assessments compared to traditional fixed-response tests provide better evidence of good instructional activities; one often thought to be more engaging for students, and are better reflections of the criterion performances that are of importance outside the classroom. For example, scores on a multiple-choice mathematics examination reflect whether a student selected the correct answer (product) but do not directly reflect the problem-solving strategies used to arrive at an answer (process).

Fuchs et al (1999) reported that one goal of performance assessment is to redirect teachers' instructional efforts to incorporate better integrated, more complex learning activities, with greater generalizability to real-life dilemmas. Assessing performance in schools promotes innovation and creativity among both teachers and students. Performance assessment requires teachers to give tasks that are useful for life (Etsey, 2005).

According to Back and Hwang (2005), performance assessment has a positive effect on the educational values of teaching and learning activities in schools in South Korea. They reported that performance assessment has positive effects on the improvement of students' intellectual abilities in areas such as achievement, learning attitude, creativity and inquiring ability.

Arguments that also support the use of performance assessments make two related but discrete claims. Performance assessments are expected, first, to provide better measurement and, second, to improve teaching and learning. Although any measuring instrument is bound to produce an amount of error, performance measures have the potential for increased validity because the performance tasks are themselves demonstrations of important learning targets rather than indirect indicators of achievement (Resnick and Resnick, 1992).

Shepard et al (1996) were of the view that performance assessment should enhance the validity of measurement by (a) representing the complete range of desired learning outcomes, (b) preserving the complexity of disciplinary knowledge domains and skills, (c) representing the contexts in which knowledge must ultimately be applied, and (d) adapting the modes of assessments to enable students to show what they know.

Shepard et al (1996) further explained that the expected positive effects of performance assessment on teaching and learning follow from their substantive validity only when assessments capture learning expectations fully. In light of this, if teachers provide coaching and practice to improve scores, their actions will directly improve student learning without corrupting the meaning of the indicator. Fuchs et al (1999) observed that teachers' use of classroom-based PA-driven instruction helped improve the problem-solving abilities of their students.

According to Resnick and Resnick (1992), PA-driven instruction may remove pressures to teach isolated facts and skills while offering teachers incentive to provide extended thinking activities.

## 2. Statement of the Problem

The most frequently used format of teacher-made tests for formative and summative purposes in the classroom is the multiple-choice type. The over dependence on the use of objective tests in the classroom has affected more than the form of subject-matter knowledge. Objective-type tests make use of items at the knowledge level rather than more cognitively complex levels. Therefore, a broader range of assessment tools are needed to capture important learning goals and processes and to connect assessment to ongoing instruction. The obvious change in the classroom has to be in two parts; a change in the traditional approach of teaching mathematics to PA-driven instruction and the use of performance assessment tasks. When these changes are effected it will offer the students an opportunity to reason critically, to solve complex problems and to apply this knowledge in real-life situations. Performance assessment in mathematics is primarily concerned with connecting classroom learning to the real world applications of mathematical concepts. However, with the influx of question and answer pamphlets in mathematics, in Senior High Schools (SHS) in Ghana most students only learn mathematics by re-solving the already answered questions. Most of the mathematics teachers do not teach beyond these questions and answers pamphlets.

This situation prevents the students from acquiring the needed problem-solving skills. It only encourages them to remember isolated facts needed to 'solve' the mathematical problems. They therefore, solve the problem without understanding why. The study was set out to investigate the effects of performance assessment driven instruction on students learning in mathematics at the Senior High School level in Ghana. It was to determine whether students' attitude to mathematics would improve if mathematics teachers in Ghana at the Senior High School level were to use performance assessment-driven instruction regularly in their classroom teaching.

## 3. Purpose of the Study

The purpose of this study was to find out the effects of the use of performance assessment driven instruction on students' attitude and achievement in mathematics at the Senior High School level in Ghana.

## 4. Hypotheses

The following two hypotheses guided the study.

1. $H_{0:}$ There is no statistically significant difference in the mathematics achievement of students who are taught with performance assessment-driven instruction (experimental group) and students' who are taught using the traditional approach (control group).
2. $H_0$: There is no statistically significant difference in attitude to mathematics between students who are taught with performance assessment driven instruction (experimental group) before and after the instruction.

## 5. Significance of the Study

The study was to provide better insight into the relationship between the instructional modes (PA-driven instruction and traditional approach) and students' performance in mathematics. This will encourage mathematics teachers to refocus their teaching to be more activity-based and student-centred.

The study was also concerned with the effect of PA-driven instruction on students' attitudes towards the learning of mathematics.

## 6. Delimitation of the Study

Due to the nature of the school system, the performance assessment tasks used were not extended projects; in this particular study, the duration for each test was two hours.

**7. Research Design**

The study conducted was a quasi-experimental nonrandomised control group, pre-test-post-test design. According to Ary et al (2002), quasi-experimental designs do not include randomisation and are used where true experimental research is not feasible. The quasi-experimental design was used for this particular study because in a typical school situation it is very difficult to reorganise classes to accommodate a randomised controlled trail. It was, therefore, necessary to use intact classes. A coin was tossed and the head was assigned to the control group and tail to the experimental group.

The cross-sectional presentation of the research design, which is nonrandomised control group, pre-test-post-test, is as follows.

| Group | Pre-test | Independent Variable | Post-test |
|---|---|---|---|
| Experimental | $Y_1$ | X | $Y_2$ |
| Control | $Y_1$ | – | $Y_2$ |

In this design, the two groups of subjects were given a pre-test, then the experimental group was given a treatment and after the treatment, a post-test was administered to the two groups. The control group was also given a form of treatment (placebo) but this was different from that of the experimental group in terms of the mode of assessment during the period of administering the treatment.

Ary et al. (2002) stated that the use of pre-test enables one to check on the equivalence of the groups on the dependent variable before the experiment begins. If there are no significant differences in the pre-test, then selection as a threat to internal validity is eliminated and therefore one can proceed with the study. However, if there are some differences, then the researcher can use ANCOVA to statistically adjust the post-test scores for the differences

7.1 Population

The population for the research consisted of all first-year senior high school students in Cape Coast Metropolis. The accessible population was the all the 400 first year students of Ghana National College.

7.2 Sample and Sampling Procedure

First-year science classes were allowed by the school authorities to take part in the research. Two of these classes were randomly selected from the five first-year classes for the study. A total of eighty-two students took part.

7.3 Instruments

Performance assessment items require students to think deeply about a concept and demonstrate their understanding. The format of performance assessments can vary considerably. For the purposes of this study, the test developed was meant to be completed individually.

Two equivalent performance-based assessment tests were developed by the researcher. Test items were developed based on the selected topics to reflect the purpose of the study by the researcher. Answers to the equivalent performance-based assessment tests were developed with the help of assessment and mathematics experts.

Regarding attitude, a five point Likert-type questionnaire consisting of fifteen questions on students' attitude towards mathematics was developed for the study. The questionnaire was adapted from a questionnaire developed for investigating the effects of computer-based instruction on performance in physics in Botswana by Thomas and Emereole (2002).

7.4 Pilot testing

The reliability estimates for pre-test and post-test were 0.67 and 0.70, respectively, using K-R 20 formula. The reliability estimate of the Likert-type questionnaire was 0.64. The content validity was also established by matching the test questions to specific objectives as required by the mathematics syllabus.

7.5 Data Collection Procedure

Initially the two groups were pre-tested. They had eight periods of mathematics each week and a period was 40 minutes. This means that a total of 320 minutes was used each week to administer the treatment. The focus of the treatment was on the use of performance assessment test items in learning mathematics. Six weeks were used to administer the treatment. After the treatment the two groups took a post-test.

7.6 Data Analysis

The independent samples t-test was used to test hypothesis 1 and the paired sample t-test was used to test hypothesis 2 at $\alpha = .05$.

## 8. RESULTS AND DISCUSSION

The pre-test result for both experimental and control groups are presented in Table 1. Table 1 displays the descriptive statistics and the independent samples t-test values of the pre-test scores of the students who participated in the study.

**Table 1: Means, standard deviations and independent samples t-test values of pre-test scores of students in the Experimental and Control groups**

| Group | N | Mean | SD | Df | t-value | p- value |
|---|---|---|---|---|---|---|
| Experimental | 42 | 18.4 | 6.7 | 78 | 1.2 | .24 |
| Control | 40 | 16.2 | 10.0 | | | |

The independent samples t-test results indicated that there was no significant difference between the experimental (M= 18.4, SD= 6.7) and control (M= 16.2, SD= 10.0) groups, t(78), = 1.2, p> 0.05.

8.1 Hypothesis 1

To test hypothesis 1, the mean scores, standard deviations and independent samples t-test values of post-test scores (in mathematics) for students in both experimental and control groups were computed. The results are shown in Table 2.

**Table 2: Means, standard deviations and independent samples t-test values of post-test scores of Experimental and Control Groups**

| Group | N | Mean | SD | Df | t-value | p-value |
|---|---|---|---|---|---|---|
| Experimental | 41 | 43.8 | 18.8 | 73.5 | 4.27 | .00 |
| Control | 35 | 27.4 | 14.7 | | | |

The independent samples t-test result indicates that there is a statistically significant difference between the post-test mean scores of the experimental group (M = 43.8, SD = 18.8) and the control group (M = 27.4, SD = 14.7) t (73.5) = 4.27, p =.00. Therefore, the two groups were statistically significantly different in their mathematics achievement after the introduction of PA-driven instruction to the experimental group. The null hypothesis is, therefore, rejected.

The results indicate a statistically significant difference in the post-test scores of the students from the two groups: the students in the intervention classroom (experimental group) achieved higher scores than the control group students. Furthermore, their mean score was substantially higher than that of students from the control group.

PA-driven instructions afforded the experimental group a lot of teacher-guided discussions in the classroom. These discussions generate lots of ideas and, therefore, enhanced the student's understanding of the problem at stake. Students appeared to be motivated towards their lesson when performance-driven instruction was used. Performance-driven instruction also helped the students to solve problems step by step, thereby causing the students' interest in mathematics to increase.

This result confirms Fuchs et al. (1999) finding when they studied the effects of classroom-based performance assessment-driven instruction. They found that students in PA-driven instruction classes demonstrated stronger problem-solving skills than the comparison groups that were not PA-driven.

8.2 Hypothesis 2

A Likert-type questionnaire of 15 statements was administered to the experimental group to elicit their responses on their attitude to mathematics. In each of the statements respondents were asked to indicate their level of agreement of the statement. There were 42 students who responded to the questionnaire on both occasions that is before and after the treatment. The findings are shown in Table 3.

**Table 3**: **Means, standard deviations and paired samples t-test values of the Experimental Group attitude to mathematics**

| Group | N | Mean | SD | Df | t-value | p-value |
|---|---|---|---|---|---|---|
| Before | 42 | 37.7 | 6.3 | 81 | 12.52 | .000 |
| After | 42 | 53.6 | 7.6 | | | |

The purpose of Hypothesis 2 was to find out if there existed any significant difference in the experimental group's attitude to mathematics before and after the treatment. A mark of 75 was obtained if a student 'strongly agreed' with all the statements and if a student 'strongly disagreed' with all the statements then a mark of 15 was obtained. Based on this a cut-off point of 50 was used as a measure for positive attitude to mathematics. The experimental group showed a more positive attitude to mathematics after the treatment than before (53.6 > 37.7).

The paired samples t-test result indicates that there is a statistically significant difference in the attitude of students to mathematics before and after the treatment. The null hypothesis is, therefore, rejected. The experimental group showed a more positive attitude to mathematics after the treatment than before.

Instructional activities related to daily life activities appeal to most or all forms of intelligence to cater for different individuals. The objectives focused on student achievement and attitude to mathematics.

Results from Hypothesis 2 indicate a statistically significant difference in the attitude of experimental group students after they had been taught using the PA-driven instruction. The three highest-rated statements on the Likert type questionnaire were "mathematics makes me an independent thinker" (M = 5), "I understand the concept taught better when my teacher solves more examples" (M = 4.5), and "I think I can handle more difficult mathematics when my teacher uses several methods." (M = 4.5). The lowest rated statement was "The use of different instructional strategies offer me greater flexibility in for solving mathematical problems" (M = 2). This low score can be attributed to the traditional way mathematics is taught in most classes where students are presented with facts and they are to memorise them. This method of teaching has the potential of choking creativity in students. Solving mathematical problems should challenge the creative abilities of students.

Even though the experimental group showed a positive attitude to mathematics after the treatment the mean value of 53.7 is just above the cut-off mean mark of 50. Results of this study generally support previous research regarding the value of PA-driven instruction.

## 9. Conclusion and Implications of the Findings for teaching mathematics

The use of PA-driven instruction in the teaching and learning of mathematics in this study had an encouraging effect on students' attitude towards mathematics especially on students' motivation, independent thinking and understanding in solving mathematical problems. To increase students' positive attitudes to mathematics it is necessary to provide positive experiences in the classroom to portray positive values associated with mathematics and its importance to the society. Students' achievement in mathematics also improved. PA-driven instruction encouraged the students to own the process of solving the given problem.

## 10. Recommendations

The following recommendations are made based on the findings:

1. Mathematics teachers at the senior high school level should make performance- based assessment tasks part of their lessons. Therefore, it is recommended that mathematics teachers should receive training programmes to equip them with knowledge and skills to enable them to use PA-driven instructions for their mathematics lessons.
2. Mathematics teachers should choose activities and mathematical problems which will engage the creative capabilities of their students.

## 11. Limitations of the Study

The present study has some limitations that warrant mentioning. The sample used for the study is not large enough to permit meaningful generalisations to other Senior High School students in Ghana. Another limitation was the teacher skills and ability since two teachers taught the two groups. Attitude scales are of limited validity. They don't predict behaviour very well. Words on a printed page bear little resemblance to actual situations.

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**APPENDIX 1**

This study is being conducted to find out the effect of performance assessment- driven instructions on Senior High School Form 1 students' attitude and achievement in mathematics in Ghana. You are kindly invited to participate in the study by completing the questionnaire. You are assured that any information given is solely for academic purposes and would be kept confidential.

**INSTRUCTION**: Tick (√) only once option which best suits you.

SEX: Male ( ) Female ( )

Strongly Agree, Agree, Uncertain, Disagree, Strongly Disagrees

| | SA | A | U | DA | SDA |
|---|---|---|---|---|---|
| 1. Mathematics is my favourite subject. | | | | | |
| 2. I understand the concept taught better when my teacher solves more examples. | | | | | |
| 3. My level of motivation in mathematics increaseswhen able to solve mathematical problems. | | | | | |
| 4. I enjoy solving more problems when the requirement of each question is clear and unambiguous. | | | | | |
| 5. I think I can handle more difficult maths when my teacher uses several methods. | | | | | |
| 6. My creativity in solving mathematical problems increases when my teacher uses several methods for to solve mathematical problems. | | | | | |
| 7. The use of different instructional strategies offers me greater flexibility in for solving mathematical problems. | | | | | |
| 8. I learn more materials when different instructional strategies are activity-based. | | | | | |
| 9. I dislike mathematics. | | | | | |
| 10. Mathematics is dull and boring. | | | | | |
| 11. I am able to solve mathematical problems without too much difficulty. | | | | | |
| 12. Am happier in a maths class than in any other class. | | | | | |
| 13. I want to continue studying maths when I am older. | | | | | |
| 14. Mathematics is important for everyday life. | | | | | |
| 15. Mathematics makes me an independent thinker. | | | | | |

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