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Role of Practical Activity Method in Improving Understanding and Problem-Solving Skills of Physics Students

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Abstract. The objective of this study was to use the practical activity method to improve the understanding and problem-solving skills of physics students at School A in the Eastern Region of Ghana. The study used 29 students in the Form 1. Sc. 1 class, of which 27 were boys and two were girls. The instruments used to gather data were achievement tests and observations. Simple statistical methods such as pre-intervention lessons were designed and administered to find the reasons students had problems understanding physics concepts and their inability to solve problems in physics. Several activities were undertaken to enhance students' understanding and problem-solving skills. This research revealed that the use of practical activity-based methods in the teaching and learning process of physics enhanced students' performance remarkably. The findings from this research showed that students' performance was elevated during the series of lessons administered. The students got a better understanding of concepts and were able to make real-life applications of concepts. This subsequently increased their contributions and participation during lessons. Conclusions were drawn and suggestions were made for teachers who are faced with similar problems of improving students' performance in physics.

Keywords: Problem-solving skills, Intervention, Observation, Achievement test

Introduction

Physics, as a branch of natural science, deals with matter, its constituents, motion, behavior through space and time, and the related concepts of work and energy. However, it was often perceived as one of the most challenging subjects in the curriculum, leading to low grades and decreased interest among students. To address this issue, it was crucial for physics teachers to focus on developing their students' understanding and problem-solving skills. To improve students' understanding and problem-solving abilities, the researcher explored various interventions, including activity-based teaching methods, ample problem-solving approaches, peer tuition, and analytical problem-solving approaches. Among these, the activity-based teaching method demonstrated significant efficiency and effectiveness. As such, the study focused on this method as the primary intervention. The data collection instruments employed in this study included observation, achievement tests, and interviews, ensuring the reliability and validity of the findings. The researcher was highly confident in the significance and relevance of the work and its findings.

Purpose of the Study

The study aimed to employ the activity-based method approach to enhance the understanding and problem-solving skills of Form 1. Sc. 1 students of School A.

Research Objectives

The objectives of the study were to:

a) Identify factors inhibiting students' understanding and problem-solving abilities.
b) Implement the activity-based teaching method to improve students' skills.
c) Devise ways to enhance students' understanding and problem-solving abilities.

Research Questions

1. What are the causes of the students' inability to understand the concept of physics?
2. To what extent will the activity-based method of teaching improve students' understanding and problem-solving skills?

Literature Review

Ways of Improving Understanding and Problem-Solving Skills in Learners

Numerous studies have focused on improving understanding and problem-solving skills in physics education. Employing multiple problem-solving approaches and activities could enhance students' problem-solving capabilities. Des Forges and Fox (2002) see multiple problem-solving in the teaching and learning of physics as a means to provide learning experiences with phenomena. Guiding students through logical steps in problem-solving, such as dimensional analysis, helped develop effective problem-solving strategies. Creating opportunities for active learning, collaboration, and personal knowledge construction through activity-based learning (ABL) could significantly boost students' performance and motivation.

Activity-Based Teaching Method

Activity-based learning (ABL) was a pedagogical approach that actively engaged students in the teaching and learning process, moving away from the traditional passive observation model (Biswas et al., 2018). According to Alyahyan and Düştegör (2020), ABL encouraged students to participate actively, transforming information into personal knowledge that could be applied in various situations. By fostering collaboration and an active role for students, ABL distinguished itself from conventional teaching methods. Reflection is an essential part of the ABL curriculum. It helps students to play a key role in the teaching and learning process

An effective teaching and learning process heavily relies on students' motivation. According to Harmer (2009), Teachers focus on three things when they speak to their students. The second one which is of greater importance is that teachers must think of what they will say to their students. This will motivate them. Incorporating a variety of activities in the active classroom setting was imperative for successful knowledge construction.

According to Khan et al. (2020), ABL has proven to be a successful teaching model, particularly in science education. By utilizing real-life experiences as a basis for learning activities, ABL equipped students with essential skills, such as communication, design, leadership, project management, and lifelong learning. The practical application of these skills prepared learners for future challenges in their personal and professional lives.

Learning activities if based on "real life experience" help learners to transform knowledge into their personal knowledge which they can apply in different situations (Edward, 2001). Learning activities provide opportunities for experiential learning which involves links between thinking and doing. It is assumed that students who handle the learning activities successfully have learned the concept of performing that particular activity

In the context of physics education, the activity-based teaching method held great promise for enhancing students' understanding and problem-solving abilities. The hands-on and interactive nature of ABL empowered learners to actively explore and construct their knowledge, enabling a deeper grasp of complex physics concepts. By employing ABL in the teaching of physics, educators could create an environment that nurtures curiosity, critical thinking, and practical application of scientific principles. Overall, ABL emerged as a

valuable approach to improving physics education and inspired students to embrace the wonders of the physical world.

Research Design and Methodology

Research Design

The research design was a framework or structure according to which information was collected using the minimum money and time (Cohen, Manion & Morrison, 2007). The plan and structure of the investigation were used to obtain evidence to answer research questions. The methodology used for this work was action research. Action research is a small-scale intervention in the functioning of the real world and a close inspection of the effects of such interventions. According to Nolen and Putten (2007), action research is capable of addressing educational gaps and ethics. The purpose of choosing action research was to effect positive educational change. In this study, the researcher aimed to improve the understanding and problem-solving skills of Form 1. Sc. 1 students of School A in the study of physics using the activity-based method of teaching, which involved the incorporation of the 'understanding of basic mechanics' method of problem-solving and other appropriate processes of problem-solving in the teaching and learning of physics. Pre-intervention activities were organized for the confirmation of the existence of the problem, as well as post-intervention activities to measure the effectiveness and impact of the intervention.

Research Instruments

Observation and test items were the main instruments used for the collection of the data.

Test

Test as an instrument was used in describing one or more characteristics of a student using either a numerical scale or a classification scheme. At the intervention stage, five tests were conducted. The tests were of the same difficulty level and required similar skills to do or answer them. Some test items were repeated but with variations in numbering as well as in content.

Observation

The researcher undertook spur-of-the-moment observation of some physics lessons. This was done to create suppositions to be tested later, in an investigation or using formal observation. This process was by listening and watching (observation). Emphasis was laid on teaching strategies used by the physics teacher and the responses of students all over the mode they learn.

Population

There were two types of populations taken into consideration during this research. Target population and accessible population. Target population refers to the entire group of individuals or objects to which the researcher is interested in generalizing the conclusions. The target population is also known as the theoretical population. Also, the accessible population in research is the population researchers can apply their conclusions. This population is the subset of the target population and is also known as the study population.

It is from the accessible population that the researchers drew the samples.

The target population of this study included all physics students in School A. The accessible population used in this study covered Form 1. Sc. 1 students. They were used for the study because the researcher was assigned to this class.

Data collection procedure

There were interactions with each of the participants before data collection started. The interactions were intended to build up like-mindedness with every one of the members. An

additional purpose of the familiarisation was to explain the purpose of the study to the participants and to elicit maximum cooperation so that the objectives of the study would be proficient.

After each test was issued to the students, a time frame was allowed so that the students could respond to them appropriately within the stipulated time. The tests were personally administered by the researcher to ensure that the test got to the participants directly. It was also to explain any part of the test instruction that posed a challenge to the students. Extra information for the study was acquired through informal observation.

Intervention stage

During the intervention stage, many practical activities were involved in the physics lessons. Class exercises and tests were given regularly at the end of each lesson. Exercises were marked promptly and students were guided to do their corrections.

The intervention took five weeks and it began from the first week of March and ended in the third week of April 2023. The interventions were conducted in the mornings on Tuesdays and Thursdays in the five weeks. The duration of each lesson was 50 minutes

Implementation of the design

The following were carried out during the implementation of the intervention:

i. Regular experimental (practical) and testing and learning activities were undertaken Most of the lessons were taken in the laboratory and this provided enough space for students to carry out a series of activities. Much emphasis was placed on the role of practical activities in science (physics) teaching and learning. Great interest was aroused in students when they saw some practical demonstrations which in turn increased their liking for physics. This was achieved through the use of hands-on activity learning methods with relevant teaching and learning materials for specific topics being treated. A lot of activities were conducted during each lesson. The students were put into groups of four with a group leader each and detailed instruction and relevant teaching and learning materials were given to them to perform various activities. Mixed-abilities groups were also used where the academically inclined students were made to assist group members with difficulties. Seven lessons were taught during the intervention stage but five of them were reported.

ii. Regular class exercise, test and homework were conducted. The practice of giving exercise immediately after each lesson was adopted to induce students to be attentive during the teaching and learning processes. At regular intervals, class tests were conducted to enable students to prepare well and keep them in touch with the subject. It removes the fear and panic of exams from the students and also serves as a means of determining the student's level of understanding of a topic taught. The rate at which homework was given to the students also offered them opportunities to adopt the attitude of problem-solving as an integral part of learning physics.

a. Prompt marking of students' exercises

Students' exercises were marked just after they submitted them. Also, good work done was motivated with encouraging words and phrases such as "well done", "excellent", "good", "keep it up", "Neat work'' etc. to develop confidence and positive self-image in the students and weak students were asked to buck up or can do better

Post-intervention design

The study focused on improving the understanding and problem-solving skills of students using the activity-based teaching method. This post-intervention was planned and selected due to the nature of the problem. The pre-intervention findings stipulated rote learning as the main cause of the problem, as students were also interested in recalling what they knew about the problem in terms of definitions, formulas, and units without spending time on the problem to understand and determine what it really entailed. Activity-based

teaching was diagnosed as the main solution to the problem. The post-intervention design involved the strategic employment of the "understanding of basic mechanics" method of problem-solving with much focus on the activity stage in the teaching and learning of physics. The post-intervention was not limited to practical mechanics or mathematics-oriented problems in physics but to every physics problem.

Data Analysis

Data analysis was the process of bringing order, structure and meaning to the mass of data collected. This mainly involved making sense of the data. For the purpose of this study, straightforward analysis and better understanding, the data collected from the study were analyzed using simple frequency counts and percentages to produce sophisticated ways of dealing with topics and extending existing conceptual frameworks.

Pre-intervention Results

Table 1: **Pre-Intervention Lesson One Test Results**

Marks (x)	Frequency (f)	Fx	Percentage (%)
0	2	0	7.0
1	3	3	10.3
2	5	10	17.2
3	7	21	24.1
4	8	32	27.6
5	1	5	3.4
6	2	12	7.0
7	0	0	0.0
8	1	8	3.4
9	0	0	0.0
10	0	0	0.0
Total	29	91	100.0

Mean mark = $\frac{\sum fx}{\sum f} = \frac{91}{29}$ =3.1

Post Intervention Results

Table 2: Post Intevention Test Results

Marks (x)	Frequency (f)	Fx	Percentage (%)
0	0	0	0.0
1	0	0	0.0
2	0	0	0.0
3	0	0	0.0
4	1	4	3.4
5	2	10	6.9
6	2	12	6.9
7	4	28	13.8
8	6	48	20.7
9	8	72	27.6
10	6	60	20.7
Total	**29**	**234**	**100.0**

Mean mark = $\frac{\sum fx}{\sum f} = \frac{234}{29} = 8$

Analysis of Research Questions

What is the cause of the student's inability to understand the concept of physics?

From the analysis of the results obtained from the evaluation test conducted during the pre-intervention lesson one above, the performance of students during the pre-intervention test was low. The majority of the students could not define simple terms such as mass, and density. The information in Table 1 indicates that 7 students representing 24.1% got the approximate mean mark of 3. The general performance of the whole class was below average. The modal mark was 4 with 8 students representing 27.6%. One (3.4%), two (7.0%), and one (3.4%) students got marks of 5, 6, and 8 respectively. The finding here is that the majority (86.2%) of the students' performance was below average and few (3.4%) performed averagely and just 10.4% performed a little over average. The above analysis of the pre-intervention test indicates that the general performance of the students was below average and therefore needed to buck up.

To what extent will activity method of learning improve students' understanding of physics lesson?

The activity-based learning techniques continuously enhanced students' understanding of some misconceptions in physics considering the analysis of the results obtained from the evaluation test conducted during the post-intervention.

From Table 2, six students representing (20.7%) scored the full mark of ten (10). Eight, six, and four of the students representing 27.6%, 20.7% and 13.8% had nine, eight and seven of the marks each respectively. Two of the students representing 6.9% scored six. Two students score half (5) of the total mark 10 and one student scored below it. The mean mark eight for the data largely exceeded half of the total mark. Here six of the students performed averagely by obtaining the mean mark (8). Nine of the students scored below the mean mark of 8 as against fourteen (14) of the students who scored above the mean mark (8) and thus performed exceptionally well. A discovery in Table 2 is the modal mark, which is nine (9) of which a whooping great number of eight (8) students representing 27.6%, showing peak improvement in the student's performance. The finding here is that the majority (96.6%) of the students attained a high-test result as an indication that the practical activity method of learning method improved the student's understanding of concepts in physics.

Discussions of Results

From the literature reviewed, the activity method was defined as a technique adopted by a teacher to teach through activities in which the students participate thoroughly and bring about efficient learning experiences. It was a method in which the child was actively involved both mentally and physically. Learning by doing was the main focus of this method, and the more a person learned, the longer he/she retained.

Practical activity teaching was an approach adopted by the researcher whereby activities were used to bring about an effective learning experience. The fundamental purpose of much practical work was to help students make links between two domains: the domain of objects and observables (things we can see and handle) and the domain of ideas (which we cannot observe directly) (Vila Thong, 2011). The activity method of teaching was student-centered learning that was taught through many different activities such as:

1. Exploratory – gathering knowledge, concepts, and skills.
2. Constructive - Gaining experience through creative works.
3. Expressional - Presentation.

For more than a century, practical work activities have played a central and distinctive role in physics education. However, these authors remarked that for many students, practical

work was mainly manipulating equipment (doing) but not manipulating ideas (thinking). However, the hands-on activity technique enhances the creative aspect of the experience.

Conclusion

In conclusion, the activity method of learning has proven to be highly effective in enhancing the understanding, problem-solving skills, and overall learning style of physics students at School A. This conclusion is reasonable because of the data obtained in the post-intervention. Implementing this approach can lead to a more engaged and proficient cohort of physics students, positioning them for success in their academic and future scientific endeavors. Putting students in groups for practical activities led to improved observational skills. Collaborative learning experiences allowed students to learn from each other, improving their overall understanding and problem-solving skills. The findings from this study support the potential of the activity-based teaching method as an essential pedagogical approach for improving understanding in physics education and motivating students to embrace the wonders of the physical world.

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