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IMPROVEMENT OF SENIOR HIGH STUDENTS' PERFORMANCE IN HEAT TRANSFER USING PRACTICAL ACTIVITIES IN EFFUTU MUNICIPAL, GHANA

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Abstract:
This study investigated the integration of practical activities with theoretical lessons to improve students' academic performance in the concept of heat transfer at A. M. E. Zion Girls' Senior High School, Winneba, in the Central Region of Ghana. A sample of 50 female home economics students in SHS two was purposefully selected for the study. Questionnaires and test items were the main instruments used to collect data for the study. Students completed pre-intervention and post-intervention tests after using an interactive and hands-on instructional approach as an intervention. A descriptive statistical analysis was used to measure the trends in teaching and learning methods. Statistical differences between students' performance before and after the study were examined using the mean, standard deviation; t-test, mean gain, and effect size analysis to analyse the research questions. Student responses to the questionnaire revealed that 86% of the students understood the concept of heat transfer after the intervention and 94% of the study sample indicated that they would like to see physics lessons integrated with theory and hands-on activities. The average gain between pre- and post-intervention test scores was 3.74, with a p-value of 0.000** demonstrating the success of the intervention process. This study supports the use of instructional tools in the physics classroom and recommends the use of interactive hands-on activities to improve the student's academic performance.

Keywords: heat transfer; practical activity, theoretical approach, performance

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1. Introduction

The ability to impart knowledge and skills that lead to a long-term change in the learner's behaviour is a requirement of the teaching profession. Therefore, to fulfil the teacher's role, learners should be able to understand the concepts taught in the classroom. Since science is fundamental to the socio-economic development of every nation, teaching science should pave the way for promoting critical thinking among learners to enable them to apply scientific concepts to explain natural phenomena and solve problems in daily life. A large body of research on teaching and learning in science education indicates that there is a need to use interactive and more engaging methods in the classroom to engage students' interest in the subject and improve their performance (Anderson, 2006; Antwi et al., 2015; Jenkins & Nelson, 2005; Sakyi-Hagan & Hanson, 2020). According to the study conducted by Antwi (2013), interactive approaches to integrated science instruction that engage as many sensory modes as possible are likely to help students achieve more success than the old traditional instructional methods, which hurt students' performance in understanding science concepts (Antwi, 2013). However, many students perceive physics as a subject full of laws and theories, which makes it too difficult to understand, thus hindering meaningful learning and understanding of the subject. Physics involves experimental and practical procedures that enable learners to acquire the knowledge from which theories and laws have evolved. Therefore, reinforcing theory with hands-on activities can enhance students' understanding, appreciation, and meaningful application of the content taught in teaching and learning physics. To improve students' conceptual understanding of physics, instruction must be engaging and relevant to capture and maintain students' attention.

Activity-based teaching is an approach adopted by the teacher whereby activities are used to bring about effective learning experiences. The fundamental purpose of much practical work is 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) (Maulidah & Prima, 2018). For more than a century, practical work activities have played a central and distinctive role in physics education (Council et al., 2012). However, these authors remarked that for many students, the practical work is mainly manipulating equipment (doing) but not manipulating ideas (thinking). An activity-based teaching method for the researcher acts as an active problem solver for the students. It enhances the creative aspect of the experience. It also gives reality to learning. This type of learning uses all available resources. It provides varied experiences to the students to facilitate the acquisition of knowledge, experience, skills, and values. It builds the students' self-confidence and develops understanding through work. It helps to develop a happy relationship and interest in them. Shapiro and Leopold (2012) suggest that merely explaining to students about their environment may not be the best method for helping them to gain an understanding of why it is there or how the processes at work in the environment have formed it (Shapiro & Leopold, 2012). However, role-play, activity methods and interactions can give students the chance to experience these events in a physical way, which may be more appropriate to their learning style. All the above-mentioned methods of teaching science ensure the active participation of learners. Some researchers have the notion that practical work can increase students' sense of ownership of their learning and increase their motivation (Madhuri et al., 2012). Koballa and Glynn in a comparison study, reported positive impacts of a combination of lectures, teacher demonstrations, discussion, and practical work on Jamaican 10th grade [age 15–16] students' attitudes to understanding physics and reported that physics must be taught using modern approaches to the teaching of which the activity method is part (Koballa Jr. & Glynn, 2013).

The teaching and learning of integrated science subjects, which include physics, has become a basic requirement in Ghanaian schools for all students in the country. This is because of the positive impact of science and technology on society, as they offer impressive solutions to most of the challenges and problems facing humanity. This study aims to combine theory teaching with practical activities to improve Form Two Home Economics students' performance at A. M. E. Zion Girls' Senior High School, Winneba, in heat transfer. This study can serve as a guide and direction to the government and science education policy organisations on the need to provide schools with adequate amounts of modern and appropriate instructional resources to improve their academic performance.

2. Methodology

The research design used was an educational action research approach to measure the effectiveness and impact of the intervention. The accessible population of the study was the Form Two Home Economics (2HE) class at A.M.E. Zion Girls' Senior High School, which is a female single-sex school in Winneba in the Effutu Municipality. The class averaged seventeen (17) years of age, with a total enrollment of fifty (50). The teacher-made test was organised to confirm the existence of the problem as well as post-intervention activities. Again, a questionnaire was administered to all participants to obtain some facts, opinions, knowledge, and concerns about the intervention process.

To verify the validity of the survey instruments, they were thoroughly assessed by experienced physics lecturers and teachers. The test items were pilot-tested at different SHS students located in a different school that possesses similar characteristics to the studied school with twenty (20) students to ascertain the reliability of the instruments. An intervention was planned to address the concerns discovered after a comprehensive examination of the pre-intervention data. The strategies designed to overcome the problem of the students were to re-teach lessons by integrating theory lessons with practical activities with the help of material resources, charts, and videos on the modes of heat transfer.

2.1 Statistical Analysis of Data

The study indicates that 2 students, representing 4%, were less than 14 years of age. Ages 14 to 16 were represented by 14 (28%) and 17 to 19 years by 25 (50%) respectively. The 20 and older age groups were represented by 9 (18%) students. The fifty (50) students that participated were all in Form 2.

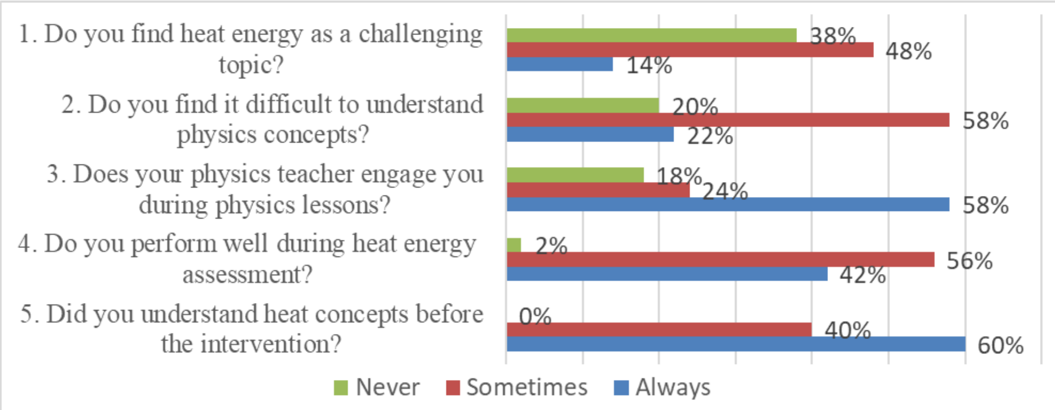

Figure 1: Descriptive Statistical Analysis of Data Before Intervention

As shown in Figure 1, 7 (14%) students indicated that they "always" find the heat energy topic challenging, 24 (48%) students indicated that they "sometimes" find it challenging, and 19 (38%) students indicated that they "never" find it challenging. Information collected again on the difficulty students have in understanding physics concepts on heat revealed that 11 (22%) students "Always" find it difficult, 29 (58%) students "sometimes" find it difficult, and 10 students (20%) also "never" have difficulty. With regards to students' engagement during physics lessons, 58% indicated that they are "always" engaged by their physics teachers, 12 (24%) students indicated that they are "sometimes" engaged, and 9 students indicated that they are "never" engaged by their physics teachers. The data from the students' assessment performances showed that 21 students answered "Always," representing 42% of the data, 28 students answered "Sometimes," representing 56% of the data, and 1 student answered "Never," representing 2% of the data. Students' knowledge of heat concepts before the intervention was divided into three categories: "Always" (30 students representing 60%), "Sometimes" (20 students representing 40%), and "Never" (0).

Figure 2 illustrates that after the implementation of the intervention, 49 (98%) students expressed "Yes" that their teacher integrated practical activities when heat energy was taught of which 1 (2%) student expressed "No". Also, 46 (92%) of the 50 students used for the study stated that they understood the heat energy concept after the integration of practical activities. Students further commented on how they understood the concept of heat energy and said that the concept resonated well with them. They went on to say that the involvement of students in the teaching and learning process, the use of hands-on activities, the interaction of classroom materials throughout the lesson, and the teacher's systematic presentation of the concept were all factors that helped them in their understanding, and only 1 (2%) student indicated "no." In addition, 38 (86%) students indicated they would like to see physics classes integrated with both theory and practical activities always because it will promote a better understanding of the concept, facilitate recall and retention of what is learned, make physics classes interesting and realistic, and relate to real-life situations in everyday life. 7 (14%) of the students indicated "No" because of the lack of facilities and equipment to conduct hands-on activities. They can rely on the notes their physics teachers give them in class while others believe they learn theoretical lessons without hands-on activities. A total of 40 students, representing 80%, indicated "Yes" that the practical lessons were interactive. 10 students, representing 20% said "No,". The number of students that said "Yes" they have an interest in studying other physics topics with the integration of practical activities was 38, which represents 76%, while 12 students, representing 24%, said "No".

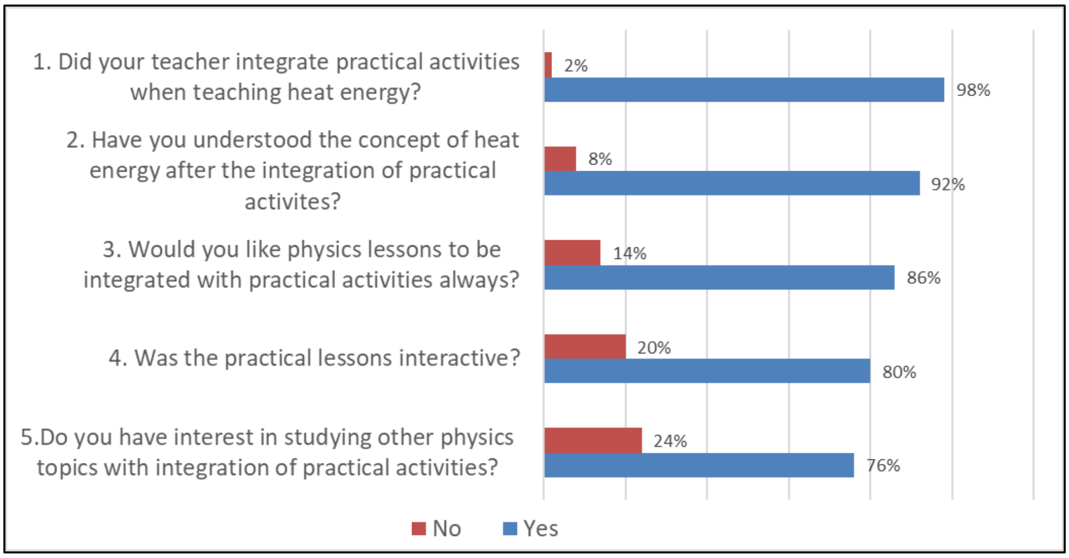

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Figure 2: Descriptive Statistical Analysis of Data After the Intervention

Table 1: Pretest and Posttest Mean Score for Study

Group	N	Pre-test Mean ($\bar{x}$)	Post-test Mean ($\bar{x}$)	Mean Gain
Study	50	3.66	7.40	3.74

The pre-test and post-test mean scores of 3.66 are shown in Table 1 (SD = 1.73) and 7.40 (SD = 1.68), respectively, after being exposed to the intervention. Respondents had a mean gain of 3.74 after the intervention. Achieving a group average of 7.40 in the post-treatment test compared with the average of 3.66 in the pre-treatment test confirms an improvement in the student's performance after the intervention.

Table 2: Magnitude of Effects on the Treatment

Group	Post-test Mean (M_2)	Pre-test Mean (M_1)	Mean Difference (M_2-M_1)	d
Study	7.40	3.66	3.74	2.43

To determine the degree to which the student's pre-test and post-test results differ, an effect size analysis was carried out using Cohen's (d) index to indicate the standardised difference between the two means, thus, comparing the mean scores of the two tests by dividing them by the standard deviation (Cohen et al., 2002). The results of d are presented in Table 2. The effect size of the study group was 2.43. These results revealed that students taught by integrating practical activities with theory lessons boost their understanding of the heat concepts.

Table 3: Inferential Statistics for Pre and Post-test Mean ($\bar{x}$) Score Difference

Test	Frequency (N)	Mean ($\bar{x}$)	SD	t-value	p-value
Pre-test	50	3.66	1.73	-10.12	0.00*
Post-test	50	7.40	1.68		

*Significant, p<.05

The results of a matched sample test in Table 3 showed that the pre-test had a mean score of 3.66 and the post-test had a mean score of 7.40. Once more, it was discovered that the pre-test and post-test standard deviations were SD = 1.73 and SD = 1.67, respectively. Additionally, the t-value and p-value were, respectively, -10.12 and 0.00**. According to the findings, there is a substantial difference between the test results obtained after the intervention and those obtained before it.

3. Discussions

The intervention, which combined practical exercises with theory teachings, was found to significantly affect how well the students performed on the test. When compared to the pre-intervention test results of the identical test, students performed better on the post-intervention test after exposure to the intervention. The ability to construct meaning and understand during the learning process is improved by using this method. Students can engage in knowledge development and meaning-making through practical work activities. The higher level of performance observed in the study confirms the attributes of the practical activities in enhancing their performance. The findings also reveal that the effect of integrating practical activities with theory lessons on students enhances performance, with significantly higher achievement test scores for students than those in the traditional classroom. That is, with the use of the proper teaching techniques, students must be able to incorporate new knowledge and experiences into the frameworks of existing knowledge. The findings back up the campaign to shift from the traditional ways of teaching to embrace the practical activities strategy.

According to Anwar, the emphasis on effective learning in a classroom has vital importance for student retention (Anwer, 2019). Students learn more quickly with activity-based training and do worse when they are not actively participating in the learning process. To ensure that the students enjoy the course and set goals, the teachers must be adaptable to the changing demands of the students and the classroom environment. The results confirm that teachers' use of instructional resources enhances students' learning. The results from the post-test showed that the use of real objects, charts, and videos helped students understand the study of heat transfer better. According to analysis, science students do better academically when they have access to and use resources such as a blackboard, an arithmetic kit, a teaching guide, a science guide, audio-visual aids, and a science kit. Instructive materials are designed with the premise that they not only keep students interested but also enhance learning outcomes generally, boost relationships and retention by involving the essential senses, and make the information simple, significant, and most frequently genuine. The use of teaching equipment and materials facilitates a teaching-learning situation that addresses the instructional needs of individuals and groups with a significant bearing on students' academic performance. Students' academic performance is significantly and favourably impacted by the use of instructional resources, including both conventional and improvised educational tools. According to the findings of the study, the student's performance increased. This is in line with the idea that physics lessons should be activity-oriented if learning is to be positively impacted. This will allow students to use their hands to operate equipment, increasing their abilities and understanding when learning. This is not far off from the reality that, to facilitate learning outcomes, the use of instructional materials is crucial in the teaching and learning process.

4. Conclusions

Innovative activities that capture students' attention and sustain it for the duration of the lesson should be used to make physics lessons fun and ensure their participation. The study concludes that the key to increasing students' performance in physics and science in general is to use an activity-based instructional strategy that engages and sustains student interest, ensures their participation, and promotes retention of learned concepts. In this way, students discover things for themselves, grasp the concept, and retain their knowledge. Hands-on activities are an excellent approach to teaching students' concepts, and they can foster and sustain students' enthusiasm for learning by making the learning process more real and understandable to them. As a result of this gain, students were more engaged in class and contributed more to the lesson, which led to an increase in performance. Integrating hands-on activities into theory classes was found to improve student performance. It was discovered that integrating practical activities with theory lessons enhanced students' performance as a result of the implemented intervention.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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