

# Effect of Practical Activities on Students' Skills, Understanding, and Performance in Physics Measurement

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**Abstract:** *This study investigated the effect of practical activities on students' process skills, conceptual understanding, and academic performance in physics measurement. An action research design was employed involving a purposively selected sample of 49 Form Two students. Data were collected using observation checklists, questionnaires, and achievement tests, with reliability confirmed by a Cronbach's alpha value of 0.960. The intervention consisted of structured practical activities conducted over three weeks. Quantitative data were analysed using descriptive statistics and paired-sample t-test, while qualitative responses were analysed thematically. Results indicated significant improvement in students' conceptual understanding and performance, with mean scores increasing from 13.6 to 29.7. The paired-sample t-test showed statistically significant differences ( $p < 0.05$ ). The findings suggest that practical activities enhance students' engagement, process skills, and learning outcomes in physics measurement. The study recommends integrating structured practical activities into early physics instruction.*

**Keywords:** Practical activities, Physics education, Process skills, Conceptual understanding, Student performance, Physics measurement, Action research.

## 1. Introduction

Form Two science students studying physics at Kaleo Senior High and Technical School (KASHTS) demonstrate weak process skills and limited conceptual understanding of physics measurement. This challenge became evident when approximately 80% (170 out of 212) of physics students were unable to apply basic measuring skills and simple measurement concepts during practical sessions, resulting in poor performance in practical tests. Contributing factors include students' limited exposure to measuring instruments and difficulty understanding concepts taught in class, despite the school having adequately equipped laboratories.

Several studies attribute students' poor conceptual understanding in physics partly to inadequate engagement in practical activities (Millar & Abrahams, 2009; Nivalainen et al., 2010). Practical activities are intended to complement theoretical instruction by allowing students to observe, manipulate, and measure real objects, thereby fostering deeper understanding. Millar and Abrahams (2009) define practical activity as any instructional approach that actively involves students in handling or observing materials to construct scientific knowledge. Such activities enhance motivation, bridge theory with real-world applications, and promote collaborative problem-solving (Lee & Sulaiman, 2018).

In many classrooms, physics learning emphasizes the memorization of facts, laws, and formulas rather than the development of conceptual understanding and scientific skills (Khan et al., 2012). This overreliance on theory has been identified as a major contributor to low performance in physics, particularly in developing countries (Abrahams & Millar, 2009; Nivalainen et al., 2010). In Ghana, physics performance at the senior high school level has consistently been poor (Anamuah-Mensah, 2007). WAEC statistics

indicate a decline in performance, with the 2019 WASSCE physics examination recording a raw mean score of 27 out of 50, compared to 28 out of 50 in 2018. A large proportion of candidates failed to attain the minimum grades required for tertiary education admission (WAEC, 2019).

These performance trends suggest a disconnect between how physics is taught in schools and how scientific knowledge is developed in practice. Researchers argue that learning outcomes can be improved by adopting instruction that emphasizes problem identification, manipulation of objects, and experimentation (Shana & Abulibdeh, 2020). Teachers play a decisive role in implementing such instructional approaches, as their beliefs and practical knowledge significantly influence classroom practice (Van Driel et al., 2001; Bryan & Recesso, 2006). Conceptual knowledge involves understanding fundamental principles and recognizing relationships among ideas (Levin, 2018). Instructional strategies that encourage students to actively engage with problems and explicitly explore conceptual linkages support deeper learning and transferable skills (Robinson et al., 2014). Developing conceptual understanding also requires addressing misconceptions through conceptual change, allowing learners to critically compare their existing ideas with scientifically accepted explanations (Ebenezer et al., 2010; Coştu et al., 2012).

This study examined how structured practical activities, like measuring with meter rules, calipers, micrometers, and stop-clocks, impacted students' process skills, understanding, and performance in physics measurement at Kaleo Senior High Technical School.

## 2. Research Questions

The following research questions were posed to find answers to the topic:

- What process skills are students unable to perform under physics measurement?
- What are the pre-conceptual skills of students in physics measurement?
- What effect will the use of practical activities have on students' conceptual understanding of physics measurement?
- What effect will the use of practical activities have on students' performance in physics measurement?

As a tentative answer to these research questions, the following null hypotheses were raised and tested at a 0.5 level of significance:

- There is no statistically significant difference between the performance of students' pre- test and post-test scores when exposed to practical activities in physics measurement.

### 3. Literature Review

Measurement is a fundamental concept in physics, as it is through measurements that we gain a deeper understanding of the physical world. In this literature review, we will discuss some of the important aspects of physics measurement. One of the most important aspects of physics measurement is the concept of precision. According to Taylor (1997), precision is the degree of agreement between a set of measurements of the same quantity. The more precise the measurements are, the closer they will be to each other. This is important in physics, as it allows us to reduce errors in our measurements and obtain more accurate results. Another important aspect of physics measurement is the concept of accuracy. According to Resnick and Halliday (2014), accuracy is the degree of agreement between a measurement and the true value of the quantity being measured. Accuracy is also crucial in physics, as it allows us to obtain reliable results that can be used to make predictions and test hypotheses.

In addition to precision and accuracy, another important aspect of physics measurement is the concept of uncertainty. According to Bevington and Robinson (2003), uncertainty is the degree of doubt that exists about the result of a measurement. Uncertainty is often represented by an error bar on a graph or a plus/minus value associated with a measurement. Considering measurement uncertainty helps us gauge how confident we are in our results. When it comes to

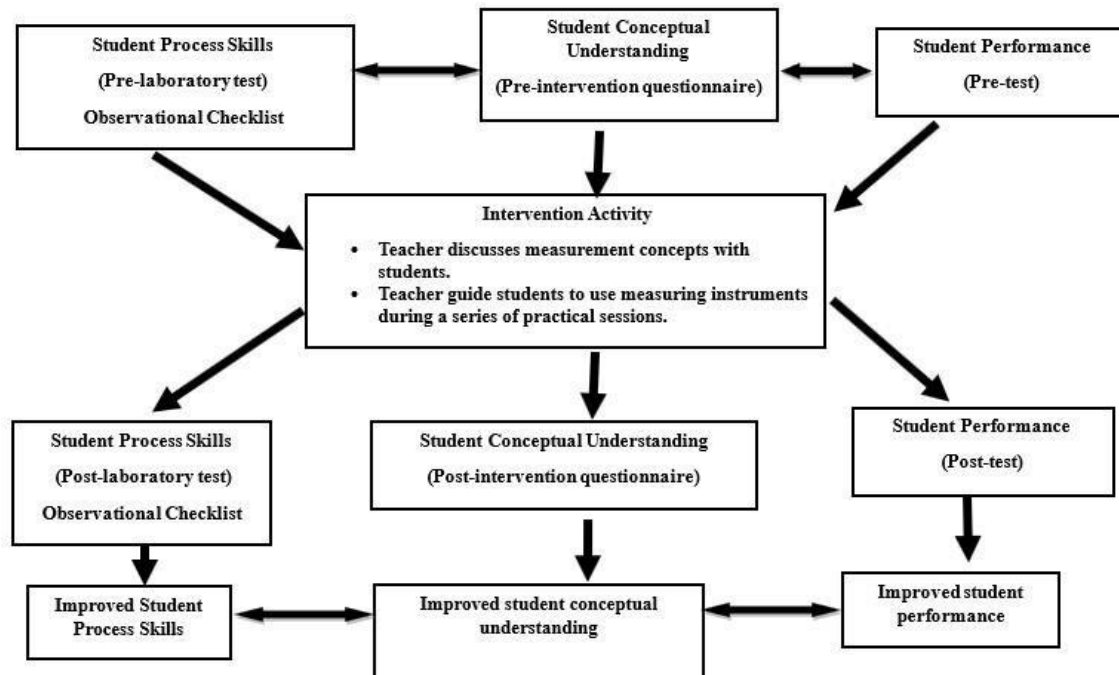
measuring physical quantities, there are a variety of different techniques that can be used. For example, in their book "Experimental Techniques in Low-Temperature Physics", White and Meeson (1999) discuss various measurement techniques used in low-temperature physics, such as calorimetry, thermometry, and magnetometry. Each technique has its advantages and disadvantages, and the choice of technique will depend on the specific physical quantity being measured.

#### 3.1 Theoretical Framework

This study was based on the constructivist theory of teaching and learning. Fernando and Marikar (2017) identified the constructivist approach to the learner's core ideas as: learning is an active construction of knowledge by the learner instead of passively absorbing information from the outside. Learning should be presented as a process of active discovery. The instructor's job in constructivist teaching is to guide students as they work to integrate new knowledge with prior knowledge and to change the prior knowledge to accommodate the new, rather than to drill knowledge into them through constant repetition or to coerce them into learning through the use of carefully calculated rewards and punishments (Knauer, 2015).

#### 3.2 Conceptual Framework

The main aim of the study was to determine the effect of practical activities on students' process skills, conceptual understanding, and performance in physics measurement. Thus, it was expected that after students had been engaged in a series of practical activities involving measurement, there would be a change in their process skills, conceptual understanding, and performance. The arrows depict the flow and influence of one variable on another with specific relations to the research objectives guiding the study. Hence, students' process skills acquisition, conceptual understanding, and improved performance in measurement are influenced by their exposure to a series of practical activities. Engaging students in a series of practical activities influences their process skills in measurement, as well as teaching students some concepts in measurement, promotes the level of their conceptual understanding in physics measurement, hence affecting their performance positively. The framework depicted in Figure 2.2 provides a ground for the findings from the study to be measured



**Figure 2.2:** Conceptual Framework on using practical activities to improve students' process skills, conceptual understanding, and performance in physics measurement

### 3.3 Strategies for Conducting Practical Activities

Practical activities have been utilized in education for a wide range of objectives. It has been used to increase scientific knowledge and conceptual understanding in science instruction (Lunetta et al., 2007). However, the many goals that practical activities have been employed for have sparked spirited debates among scholars such as Hodson (1992) and Millar (2004). Growing educational technology has had a huge impact on science's dynamic nature throughout the past few decades. Researchers interested in the progress of teaching and learning have recently focused their study on practice-based education. In every educational setting, learning by doing is by far more effective for acquiring information and abilities. According to Zittleman (2006), prior work has shown that interactive learning through inquiry processes significantly boosts learning in academic settings. Theories like progressivism, social reconstructionism, and existentialism, among others, emphasized developing one's knowledge and abilities to educate one's mind, and these popular methods have since taken centre stage in educational systems. Learner-centred approaches have received a lot of attention in recent research in teaching and learning endeavours (Twahirwa & Twizeyimana, 2020). Teachers and instructors must put up a lot of effort to capture students' attention during class. According to research by Eddy et al. (2015), internalizing one's knowledge and skills can increase learners' feelings of responsibility, which in turn can increase their engagement. Among the characteristics that affect learning sciences in contemporary education are practical works. Scientists, in particular instructors, might view practical activity as being fundamental to the goal and efficacy of scientific education. Niyitanga et al (2021) emphasized that acquiring science, technology, engineering, and math skills requires a foundation in practical work. This is because the quality of school scientific laboratories is of the highest significance. As previously established by Musasia et al (2016), studying sciences like physics mostly involves

students engaging in hands-on activities. Practical activities offer opportunities for investigation, debate, think-pair-share, and problem-solving techniques to encourage learners' involvement in their learning process.

Agreeing with Abrahams and Millar (2009), practice-based learning is once in a while attempted by most instructors in developing nations due to the shortage of assets, lacking down-to-earth aptitudes, huge course measures in secondary schools, and insufficient infrastructure. In addition, the aforementioned factors largely determine how teachers approach teaching science via practice. When the instructor allows the student to freely develop their knowledge and skills, the student may need the instructor's assistance. At this point, the teacher- student contact becomes crucial. Learners will probably build their sense of creativity via observation, critical analysis, and curiosity, which in turn form the basis of sound knowledge and abilities. The National Curriculum Framework for Science (NCF, 2005) emphasizes the importance of fostering originality, innovation, and strengthening inquiry skills in the science curriculum. Your children may learn about scientists' work and build their investigative abilities through practical activities, especially through investigative approaches to science. Learning that is both "hands-on" and "minds-on" results from good practical exercises. Numerous practical activity plans exist, each with unique advantages and planning challenges, such as demonstration and discovery learning, context-based learning, and project- based learning.

### 3.4 Empirical Evidence Based on the Use of Practical Activities

Researchers and educators support practical activity-based techniques as superior for teaching physics, citing benefits such as interdisciplinary teamwork, student engagement, and relevant learning (Anwar, 2019). This approach integrates new content with students' prior knowledge and broadens

learning opportunities. It also helps develop skills like teamwork, communication, leadership, project management, problem-solving, reflection, and lifelong learning. According to Molloy et al (2020), active participation in learning activities encourages students to seek out additional knowledge and helps them develop conceptual understanding. Hake (1998) discovered that students' conceptual knowledge in the Physics class is greatly improved by practical activity-based learning. Tremblay (2013) concluded that classes receiving practical activity-based learning performed much more accurately on the exam and displayed higher attitudes than classes receiving instruction using the conventional way. In medical education, the value of activity-based learning in promoting self-directed learning and problem-solving abilities is well-established (Barrett, 2016). Regarding the psychology of memory, research also shows that active engagement and learning by doing are the most crucial elements to raising students' accomplishment and retention levels (Hyland, 2002).

A well-organized practical assignment can boost students' motivation and sense of ownership over their education, according to Lunetta et al (2007). They said that there is strong support for the idea that laboratory work, when thoughtfully designed, well-prepared, successfully taught, and followed up, provides students with the opportunity to advance their knowledge and abilities in ways that enrich their regular classroom experiences. According to Luketic and Dolan (2013), practical activities encourage favourable attitudes and interest in science. Work that requires practical application offers motivating advantages like interest and satisfaction, skill development, science information acquisition, understanding of the scientific method, and scientific thinking. Therefore, further research into how practical work affects students' academic achievement is valuable.

### 3.5 The Benefits of Using Practical Activities in Teaching

Practice-based teaching is widely recognized as an effective method for providing students with lasting knowledge and skills (Wegner et al., 2021). With technological advances and evolving societal demands, science educators emphasize practical work to help students acquire real-world abilities. Musasia et al. (2012) found that hands-on activities in physics offer benefits such as lifelong skills, self-directed learning, experiential understanding, and revealing practical realities beyond theory. Given these advantages, practice-based approaches should be implemented in education.

## 4. Methodology

### 4.1 Research Design

This study adopted an action research approach. Action research is a systematic method used to investigate school environments with the goal of understanding and improving educational quality (Hine, 2013). According to Smith (2010), it involves practitioners conducting scientific inquiries into issues before making decisions to assess and enhance them. Lykes and Scheib (2017) note that action research is popular in education because there is always room for growth when

teaching others. Although there are numerous methods for classroom instruction, action research stands out due to its ongoing cycle of reflection. Its purpose is to improve practices across professional fields, and it is particularly useful where continuous improvement is needed, especially in teaching and learning or areas where instructional practices require analysis. This design was suitable for evaluating how practical activities influence students' process skills, conceptual understanding, and performance in physics measurements. The problem was identified through pre-intervention tasks, while post-intervention tasks were used to judge the effectiveness and impact of the intervention.

### 4.2 Sampling Technique and Sample Size

A purposive sampling technique was adopted in this study. Etikan (2016) defined a purposive sample as the type in which the Researcher handpicked the students to be included in the sample based on their judgment of their typicality. Purposive sampling involves the researcher selecting respondents who are knowledgeable about the topic of interest (Tongco, 2007). According to Campbell et al (2020), purposive sampling is the selection of a sample based on the judgment of the researcher. When it comes to picking the units to be researched, such as persons, cases, organizations, events, or pieces of data, purposeful sampling relies on the researcher's judgment. In this study, the researcher chose an intact class with a total sample size of forty-nine (49) physics students in Form Two. These forty-nine students (49) were made up of sixteen (16) students from Form Two Science, thirteen (13) students from Form Two Technical 1, eleven (11) students from Form Two Technical 2, and nine (9) students from Form Two Technical 3. These intact classes were used for the study since they lacked some measurable skills and conceptual understanding of physics measurement. Also, they have already spent a little more than a year at school and have been introduced to some basic scientific process abilities. They also learned some fundamental principles in Physics (especially in measurement).

### 4.3 Data Collection Instrument

The researcher used observational checklists, questionnaires, and tests as instruments for the collection of data. One of the earliest and most essential techniques in qualitative research methodology is observation. Non-participant observation was used by the researcher to identify the process skills students are unable to perform in physics measurement during a laboratory test. The researcher grouped the selected students for the study into ten (10) groups, with each group consisting of about five members at the science laboratory. The researcher went around and observed each group whilst they performed a laboratory test. During the observation, the researcher used an observation checklist as an instrument to collect data on their process skills in physics measurement. Questionnaires were administered to reflect lessons drawn from the literature review. The questionnaire consisted of nine (9) closed-ended and ten (10) open-ended items. It was divided into three sections which were as follows: Section A sought information on the demographic characteristics of respondents and Section B involved closed-ended items on a five-point Likert scale rated in the range Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4) and Strongly Agree (5) which sought

information on the pre-conceptual skills of students in physics measurement. Section C contained open-ended items that sought information on students' conceptual understanding of physics measurement. The achievement test was one of the instruments used. The achievement test comprised two tests, namely pre-test and post-test. This was done to assess students' performance and the effectiveness of the representation lessons after successful treatment of the selected topics. The scripts were marked and scored, and immediate feedback was given to the students. An intervention procedure was designed for implementation to ascertain its effectiveness on students' performance.

#### 4.4 Data Collection Procedures

This study involved the pre-intervention phase, intervention phase, and post-intervention phase. In the first phase of the pre-intervention, students were allowed to demonstrate some process skills by measuring physical quantities with various measuring instruments through an organized pre-laboratory test. The student's process skills during the hands-on activity were then evaluated using an observation checklist. This evaluation was done by grouping students into ten (10) groups, with each group comprising about five (5) students and being observed accordingly. A pre-intervention questionnaire was carried out by each student in each group to determine their pre-conceptual skills and level of conceptual understanding in physics measurement. Also, a general pre-test was conducted before the intervention to ascertain their performance in physics measurement.

In the second phase, the researcher taught some selected topics and organized a series of practical activities in physics measurement for three weeks, focusing on improving students' process skills, conceptual understanding, and performance. The first week of the intervention phase comprised teaching concepts related to physics measurement. The second and third phases are imbued with laboratory practical exercises and hands-on activities on how to use some measuring instruments in measurement using group work. Students were guided to perform laboratory practical experiments both in groups and on their own. The practical exercises were constructed based on the concepts and process skills developed within the week, and each lasted 90 minutes. A progressive test was carried out after each lesson, where responses were marked and distributed to students before the next lesson. This evaluation was done to enable students to identify specific strengths and areas needed for improvement.

A general discussion on the feedback was done after the distribution of the marked scripts. Weaknesses and misrepresentations of the concepts and process skills were addressed.

The post-intervention phase of the study involved monitoring the effects of the intervention strategies on the acquisition and development of requisite scientific process skills, conceptual understanding, and performance by the students. This was done by organizing a post-laboratory test where students were put into groups. Each group was observed using an observation checklist to determine how their process skills improved after the intervention activity. A post-intervention

questionnaire was also given out to each student to determine the impact of the intervention on their conceptual understanding. The responses were judged by whether they addressed the expected outcome and reflected the acquisition of concepts taught. A five-point Likert scale was used to obtain data on the pre-conceptual skills of students in measurement. On the five-point Likert scale, scores of 1 and 2 were considered as high scores, whereas 4 and 5 were designated low scores. A score of 3 indicated an average score, interpreted as being neutral about the concerned attribute. Also, a general post-test was conducted, and the scores obtained by the students during this phase were used to evaluate their performance after the intervention.

#### 5. Results

The results were based on students' engagement in laboratory activities, teaching of concepts under measurements, and learning activities in the classroom and laboratory. Data collected from students' laboratory tests, weekly intervention exercises after lessons, and questionnaires were analysed qualitatively and quantitatively. The information collected during the research has been analysed using descriptive and inferential statistics. Statistical analyses were carried out using the statistical package for the Social Sciences (SPSS) version 26 and Microsoft Excel 2016. Several tables and charts have been constructed for easy presentation of data. The students' responses were mainly presented in frequencies and percentages. A descriptive analysis of results was done to provide the basis for the findings on students' process skills and conceptual understanding, whilst an inferential analysis was done to provide the basis for the findings on students' performance.

##### Research Question 1: What process skills are students unable to perform under physics measurement?

##### Findings from Observation Made before the Student's Laboratory Test.

From Figure 4.1, the results indicated that the majority of the students, representing 80%, lack collaborative skills in conducting practicals related to physics measurement. 70% of the students also lack identification skills, while 100% of the students were unable to record the least count and zero error of a measuring instrument. 60% of the students were unable to apply a correct standard unit of measurement, as 50% of them could not avoid parallax error when taking a reading. About 90% of the students could not read standard measures to describe the dimensions of an object. Also, 70% of the students lack recording skills, as 80% of the students could not organise data and draw conclusions from it. Lastly, 50% of the students lack the skills of handling an instrument. According to Millar (2004), the use of practical activities is a necessity to increase students' science process skills. Okafor (2018) emphasised that, in order to create knowledge, solve issues, and conduct experiments, science process skills must be employed. This led to the intervention of using practical activities to improve students' science process skills. From Figure 4.2, it can be seen that students' skills improved significantly during the post-laboratory test. This could be a result of students learning new skills adopted from the intervention activity.

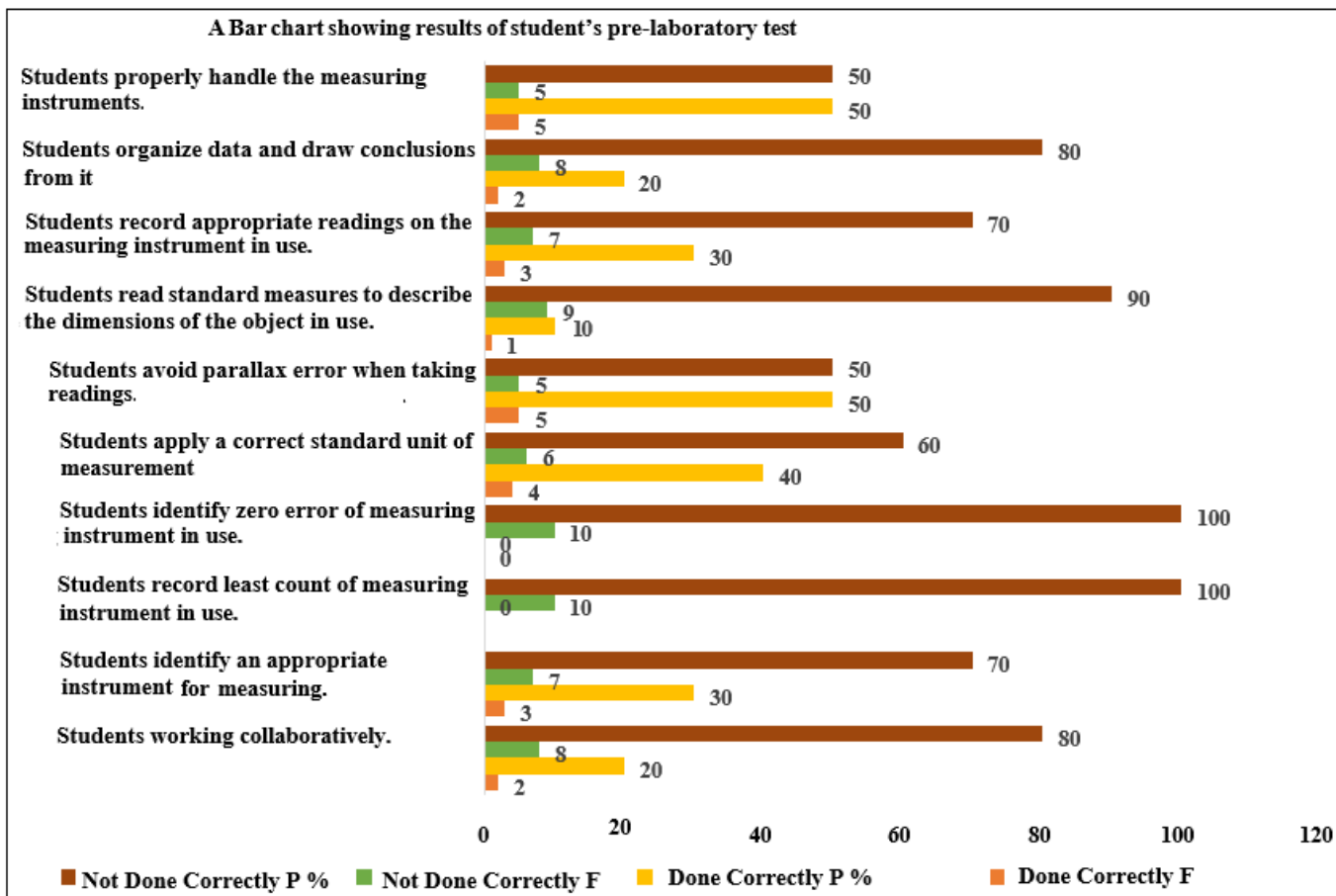


Figure 4.1: Bar chart showing the results of students' pre-laboratory test

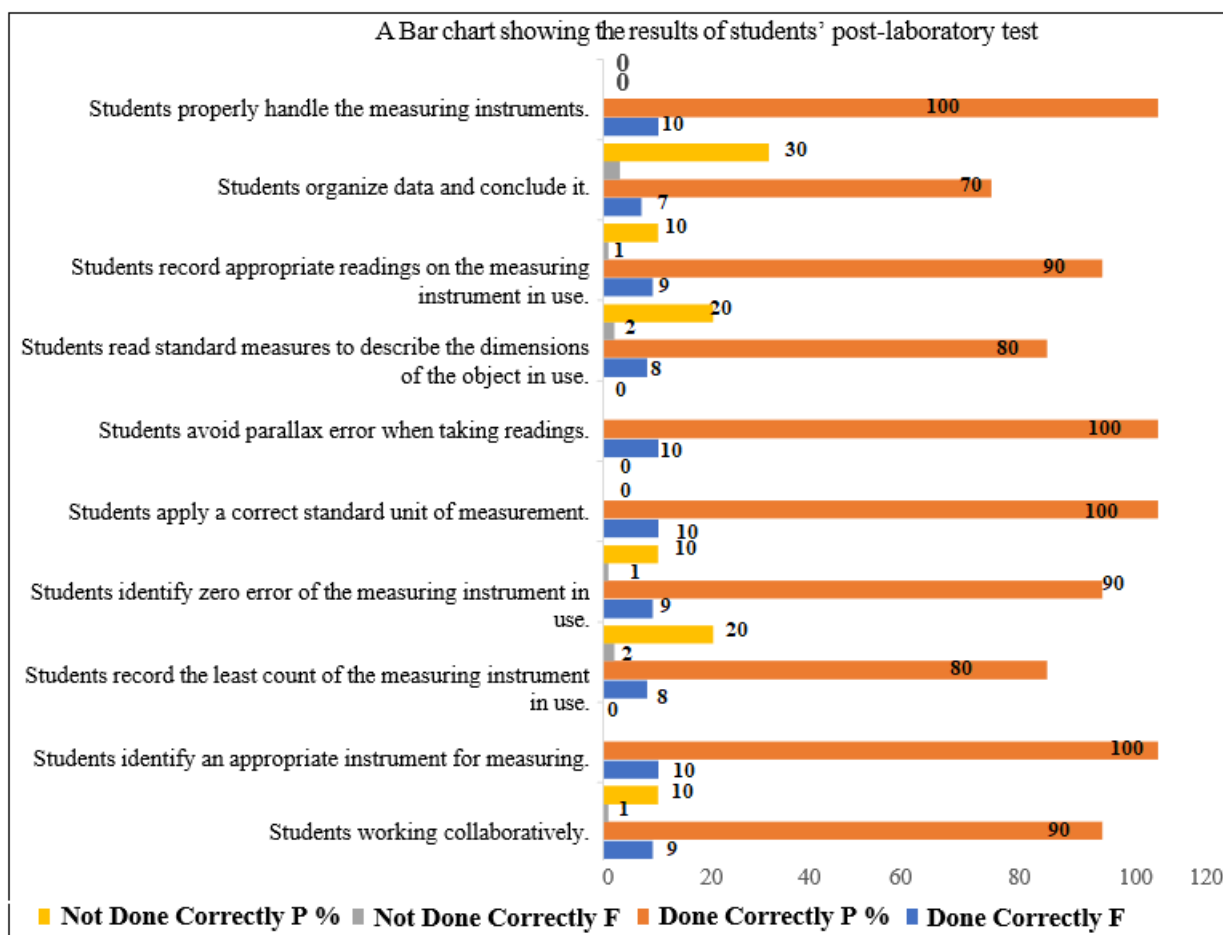


Figure 4.2: Bar chart showing the results of students' post-laboratory test

**Research Question 2: What are the pre-conceptual skills of students in physics measurement?**

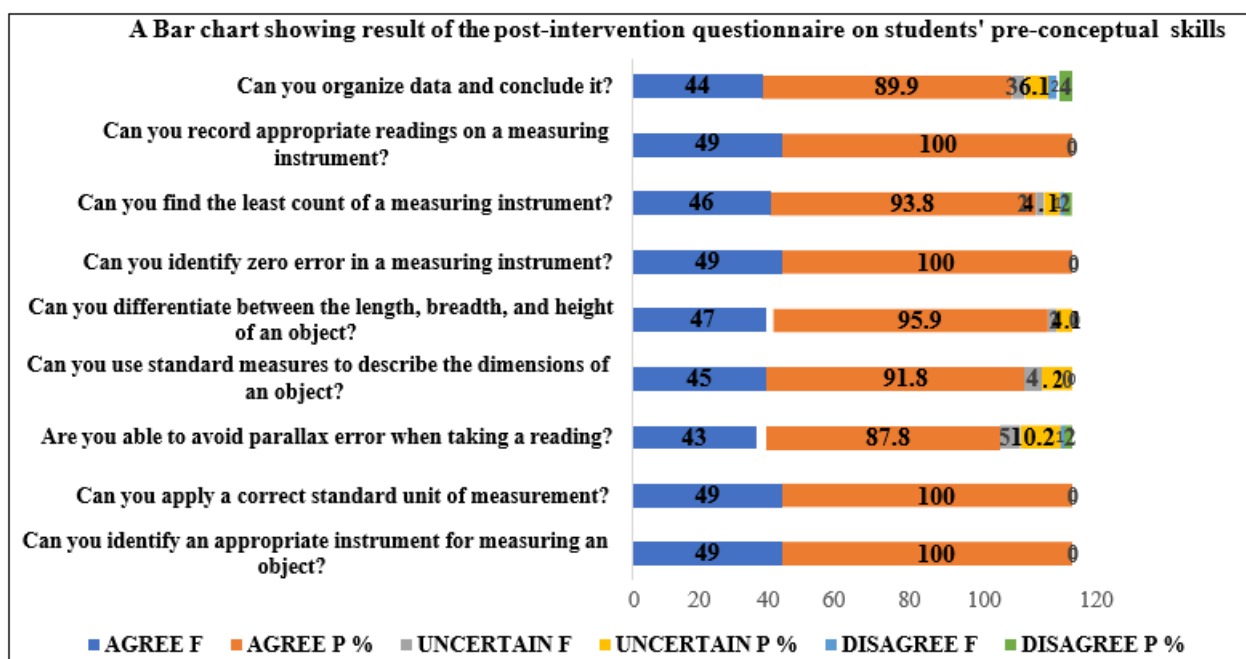
**Findings Made from Students' Pre-conceptual skills in Physics measurement.**

From Table 4.3, the pre-conceptual skills of students' inability to identify an appropriate instrument for measuring an object were in relation to the observation made during the pre-laboratory test in Figure 4.1. About 83% of the students disagreed that they can apply a correct standard unit of measurement. 69% of the students shared their thoughts on their inability to avoid parallax error when taking readings. Also, 80% disagreed on using standard measures to describe the dimensions of an object, which was also in relation to the observation made from Figure 4.1. The majority of the

students, representing 82%, indicated they cannot differentiate between the length, breadth, and height of an object. With respect to the observation made from Figure 4.1, 92% of the students disagreed on their ability to identify zero error in a measuring instrument. 86% indicated their inability to identify the least count of a measuring instrument. About 80% and 84% of the students disagreed with recording appropriate reading on a measuring instrument, as well as organising data and drawing a conclusion from it, respectively. The use of practical activities during the intervention phase resulted in changing the pre-conceptual skills of students in physics measurement. Results from Figure 4.4 showed a huge positive margin toward the pre-conceptual skills of students in physics measurement.

**Table 4.3:** Results of pre-intervention questionnaire on student pre-conceptual skills

STATEMENT	Agree		Uncertain		Disagree	
	F	P %	F	P %	F	P %
1. Can you identify an appropriate instrument for measuring an object?	5	10.2	7	14.3	37	75.5
2. Can you apply a correct standard unit of measurement?	3	6.1	5	10.2	41	83.7
3. Are you able to avoid parallax error when taking a reading?	8	16.3	7	14.3	34	69.4
4. Can you use standard measures to describe the dimensions of an object?	0	0.0	10	20.4	39	79.6
5. Can you differentiate between the length, breadth and height of an object?	3	6.1	6	12.2	40	81.7
6. Can you identify zero error in a measuring instrument?	0	0.0	4	8.2	45	91.8
7. Can you find the least count of a measuring instrument?	2	4.1	5	10.2	42	85.7
8. Can you record appropriate readings on a measuring instrument?	2	4.1	8	16.3	39	79.6
9. Can you organise data and draw conclusions from it?	3	6.1	5	10.2	41	83.7



**Figure 4.4:** Bar chart showing results of post-intervention questionnaire on students' pre-conceptual skills

**Research Question 3: What influence will the use of practical activities have on improving students' conceptual understanding in physics measurement?**

**Findings Made from How Practical Activities Will Improve Students' Conceptual Understanding in Physics Measurement**

The conceptual understanding of students exposed to regular weekly intervention of practical activities and teaching of concepts related to physics measurement improved tremendously. From Table 4.4, there is a clear indication of

students' pre-responses being improved as compared to their post-responses to the questionnaire. This is evidence that the intervention strategy adopted had helped in improving students' conceptual understanding. This means students' lack of conceptual understanding in physics measurement was, to a large extent, due to a lack of practical activities and basic concepts in physics measurement. Findings with respect to research question three were positive in that the conceptual understanding of students exposed to practical activities did improve significantly. From the research literature, Sawyer (2008) stated that conceptual understanding involves the

application of an explanation to certain novel situations that are previously known. The use of practical activities aimed at allowing students to apply concepts to real-life situation as suggested by Sawyer (2008). Antwi et al (2021) also reported that practical work was a significant tool for developing students' scientific knowledge and habit of mind, which

concur with the finding that practical activities contribute to increased ability to conceptual understanding. Based on the findings, a strong case can be made for the positive or improved effect of practical activities on the conceptual understanding of students in physics measurement.

**Table 4.4:** Results on students' responses to their conceptual understanding from pre-intervention and post-intervention questionnaires

Question	Student's Pre-responses	Expected response	Student's Post-responses
1. What determines the precision of a measurement?	It is when you determine, but you are not sure.	<i>Depends on the instrument used and its least count</i>	Depends on the instrument used and its least count
	How one takes the measurement		How close the measured values are to each other
	Is the correct measurement of the object.		The consistency of the measured values
2. What is uncertainty in measurement?	Measurement not taken perfectly.	<i>Range of possible values within which are the true values of the measurement lie</i>	Range of possible values
	No idea		The true value
	By using a micrometre screw gauge to get the measurement		The actual values of the measurement
3. A student measures a distance several times. The reading lies between 49.8cm and 50.2cm. What is the best way of recording this?	50.1cm	$50.00 \pm 0.2cm$	$50.00 \pm 0.2cm$
	52cm		52cm or 50cm
	50 cm is the best way		Find the average of the two values, that is, 50cm.
4. The number of significant figures in the measurement of 0.00807600cm is?	8 significant figures	<i>6 significant figures</i>	6 significant figures
	3 significant figures		6 significant figures
	No significant		8 significant figures
5. For an answer to be complete, the units need to be specified. Why?	It shows you what you should do	<i>Any physical quantity is made relative to a particular standard or unit</i>	The unit defines the quantity measured
	It helps you to understand		Because it is relative to a particular standard.
	It means different things.		To know the exact value measured.
6. What is the least count error?	Error by the one using the instrument	<i>An error associated with the resolution of the instrument is used.</i>	Is the uncertainty in the smallest unit that an instrument can measure.
	No response		When the reading of the instrument does not start from zero
	If you don't use the right instrument.		An error associated with the resolution of the instrument.
7. How can the least count error be reduced during measurement?	No idea	<i>Replacing the instrument with a higher resolution instrument and adapting better experimental techniques</i>	Replacing the instrument with a higher resolution.
	Being careful when taking the measurement.		Using proper and well-calibrated instrument
	By using the minimum measurement		Taking multiple readings and finding the average.
8. Can you find the diameter of a thin wire of length +B42:D472m using a ruler? State the reason for your answer?	Yes, used in the right way	<i>No, because a thin wire has a very small diameter and cannot be measured with a ruler.</i>	No, a thin wire has a very small diameter.
	Yes, by putting the ruler in the length of a thin wire		No, a ruler is used to measure the length of the wire.
	No, a micrometre screw gauge is used to measure the diameter.		No, only a micrometre screw gauge can be used.
9. What is the advantage of using the International System (SI) of units?	It helps reduce measurement errors in physics.	<i>The SI unit has only one unit for each quantity and can easily be converted.</i>	For easy conversion of units.
	To avoid wrong answers		For easy identification of the quantity measured.
	To know the specific instrument to use		It is standard and known to all scientists.
10. What is the difference between precision and accuracy in measurement?	No difference	<i>Precision is how close measurements of the same item are to each other, AND Accuracy is the degree of closeness to a true value</i>	Accuracy refers to how close a measurement is to a standard value, and precision refers to the closeness of a series of values in an experiment.
	Precision is when the correct instrument is used for the measurement, while measurement accuracy is when the exact measurement is counted.		Precision is how close two or more measured values are, but accuracy talks about the closeness of the measured value to the actual value.
	They mean correct measurement.		Accuracy is the degree of closeness to a true value, whilst Precision is how close measurements of the same item are to each other.

**Research Question 4: What effect will the use of practical activities have on improving students' performance in physics measurement?**

From Table 4.5 above, the mean (29.7) of the post-test is higher than the mean and standard deviation (13.6, SD = 4.4) of the pre-test. This shows that the difference in performance of students post-test and pre-test is significant. However, the Paired sample t-test results indicated a calculated t-value of 16.8 and a p-value of 0.010. Comparing these two results indicates a high level of statistical significance between the pre-test and post-test scores since the tabulated t-value is less than the calculated t-value and the P-value is less than 0.05. As a result, there is a statistically significant difference between the performance of students' pre-test and post-test scores when exposed to practical activities in physics measurement. Hence, the null hypothesis was rejected.

**Table 4.5:** A Paired-Sample t-test of students' pre-test and post-test scores.

Test	N	Mean	Std. Deviation	Degree of freedom	T-value	P-value
Pre-Test	49	13.6	4.4	48	16.13	0.010
Post-Test	49	29.7	7.2	48		

**Significant;  $p < 0.05$**

**T(0.05)= 1.684 Not significant;  $p > 0.05$**

**Findings Made from the Effect of Practical Activities on Students' Performance in Physics Measurement.**

Findings with respect to research question four were positive in that the performance of SHS 2 students exposed to a series of practical activities has improved. According to performance statistics published by the West African Examination Council (WAEC) between 2018 and 2019, the WASSCE for School Candidates 2019 raw mean score of 27 out of 50 and a standard deviation of 07.92 with a candidature of 762340 indicates a low performance than that of WASSCE for School Candidates 2018, where a raw mean score of 28 out of 50 marks and a standard deviation of 07.62 with a candidature of 728924 was recorded (WAEC, 2019). This shows that the way science is taught in senior high schools does not correspond to how scientists work. It has been suggested that the situation could be improved by adopting a procedure where students identify problems, handle or manipulate objects, and conduct scientific experiments. In this regard, adopting the usage of practical activities in some selected topics in physics would curb the worrying situation of students not performing well in physics, since there has been a remarkable improvement after the intervention.

**6. Discussion and Conclusion**

The study aimed at finding the effect of practical activities on students' process skills, conceptual understanding, and performance in physics measurement. The following were the findings that emerged from the study:

- 1) Most of the students, representing 80%, lack collaborative skills in conducting practicals related to physics measurement. 70% of the students also lack identification skills, while 100% of the students were unable to record the least count and zero error of a measuring instrument. 60% of the students were unable to apply a correct standard unit of measurement, as 50% of them could not avoid parallax error when taking a

reading. About 90% of the students could not read standard measures to describe the dimensions of an object. Also, 70% of the students lack recording skills, as 80% of the students could not organise data and draw conclusions from it. Lastly, 50% of the students lack the skills of handling an instrument. The results from the post-laboratory test reported that students had gained much experience in their process skills in physics measurement. This is a clear indication that the use of practical activities in measurement has improved their process skills remarkably.

- 2) Students' pre-conceptual skills towards the study of measurement changed substantially, indicating a positive effect on their process skills in physics measurement. There was a clear indication of a positive change in their pre-conceptual skills on a five-point Likert scale questionnaire before and after the intervention activity.
- 3) The conceptual understanding of students exposed to regular weekly intervention of practical activities and teaching of concepts related to physics measurement improved tremendously. From Table 4.4, there was a clear indication of students' pre-responses being improved as compared to their post-responses to the open-ended questionnaire. This is evidence that the intervention strategy adopted had helped in improving students' conceptual understanding.
- 4) Students enjoyed laboratory activities, and the experiences resulted in high performance in studying physics measurement. The analysis suggested that practical activities in physics measurement had a significant impact on student performance, as evidenced by the higher mean and standard deviation of the post-test scores (29.7, SD=7.2) compared to the pre-test scores (13.6, SD = 4.4), and the significant results of the paired sample t-test ( $0.010 < 0.05$ ,  $16.13 > 1.68$ ).

In conclusion, the study demonstrates that structured practical activities significantly enhance students' process skills, conceptual understanding, and academic performance in physics measurement. The observed improvements in post-test scores and conceptual responses indicate that hands-on learning promotes deeper engagement and meaningful knowledge construction. These findings support the integration of practical activities as a core instructional strategy in physics education. Future implementations should focus on early introduction of measurement concepts and sustained use of laboratory-based learning to improve overall student achievement.

**7. Limitation of the Study**

Academic researchers typically encounter difficulties in accomplishing their goals, and this study was not left out. Due to unscheduled time for practical activities, lack of funding, and unavailability of laboratory resources to cover the entire Senior High School physics students at large, the study was limited only to physics students at Kaleo Senior High and Technical School. Difficulty in accessing the internet or library became a challenge at times, which disrupted getting information from journals, books, and other study resources.

**Ethical Considerations**

Before data was collected, an introductory letter was given by

the university to prove that the research was legitimate and was approved by the university. The introductory letter included the details of the Researcher, the name of the university that the Researcher attends, the name of the supervisor, and the reason for doing the research at their school, among others. The introductory letter also indicated that the participants would remain anonymous and that their responses would be kept confidential. The Researcher took consent from the school heads and teachers before administering the questionnaires to them. Participants were made aware that their participation was voluntary. Participants were assured of the confidentiality of their responses. They were made aware that the information they provided was not going to be made public, and none of the respondents' names, addresses, date of birth, or any possible means by which their identity would be made public was requested. All references were duly acknowledged to avoid plagiarism.

#### Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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