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Research Article

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Validating the Use of Improvised Materials in Determining the Value of Acceleration Due to Gravity

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Abstract The study was a comparative analysis of the use of standard and improvised materials. This was considered by finding the value of acceleration due to gravity using the two sets of materials. The research design was an experimental type which was carried out by ten undergraduate students of Basic Science in the Faculty of Education, Ekiti State University, Ado-Ekiti, Nigeria. The instruments used were the standard and improvised sets of apparatus for determining the value of acceleration due to gravity. The observed values of the experiments were subjected to graphical analysis. The results of the two sets of experiments showed close comparative values for acceleration due to gravity. It was therefore recommended that the results obtained from improvised scientific materials should be accepted as being reliable just like the standard apparatus.

Keywords Standard, improvised, materials, comparative values, validation

Introduction

Science subjects involve facts and concepts that are based on experimental proofs. Scientific inventions evolved as a result of painstaking observations of processes and phenomena which are tested and validated. The teaching of science therefore cannot but be fully based on experimental confirmation of the established facts, concepts and principles, often referred to as practical.

Experimentation involves the manipulation of scientific apparatus and materials by the scientist(s). There are a number of specific materials that would constitute a set of apparatus for an experiment. These materials are often made through industrial preparation by manufacturers of scientific equipment and apparatus where the school can consult for purchases so that they can be readily available in the school laboratory. These types of apparatus are referred to as standard materials. Operationally, when students are required to perform experiment to complement the classroom theoretical lessons, one or two materials that should make up a set of apparatus for such an experiment may not be readily available in the laboratory store. Under such a situation, the students are restricted to only the theoretical discussion, contrary to the nature of scientific exploration. No wonder, [8] observed that science concepts are being taught abstractly on the teachers' perception that materials for teaching most of the concept are not available. In such a situation, a teacher with good mastery of subject matter may not deliver effectively and efficiently as the necessary learning tools are not accessible [7].

A skilled and professional science teacher is duty bond to find alternative means of providing a complete set of apparatus for the students, a process referred to as improvisation. The teachers should not take the advantage of inadequate instructional apparatus or lack of them as an excuse to resort to either poor teaching or skipping of some topics, but instead they should learn to improvise for the needed materials [10]. Improvising for scientific apparatus has been a useful step in making teaching-learning process to run smoothly uninterrupted as provisions are often made of the required apparatus for experimental confirmation or otherwise of theoretical concepts and principles taught in the classroom. [5] pointed out that improvised instructional materials involve the act of producing and using alternative resources aimed at facilitating instruction while [9] considered

improvised materials as involving the selection and deployment of relevant instructional elements of the teaching and learning process in the absence or shortage of standard teaching and learning materials for meaningful realization of specific educational goals and objectives. In a more simple term, [4] defined improvisation of instructional materials as a meaningful attempt towards finding suitable substitute or alternative to conventional science materials.

A host of researchers have proven the validity and reliability of improvised apparatus in scientific endeavours. For example, [14] observed that students taught with improvised materials performed better than those taught without such materials in physics. [4] also realized that 98% of the students taught rate of transpiration in plant with improvised photometer passed the test while only 15% of the control group passed the test. [1] noted the relevance of using improvised materials to include developing understanding as well as showing the appropriate ways of executing scientific endeavours. Also, [11] submitted that the utilization of improvised instructional materials take adequate care of the three domains of cognitive, affective and psychomotor, thereby reducing the abstractness of the scientific concepts.

The importance of improvisation may include, but not limited to:

- develop in students and teachers creative skills
- create practical and physical link between science and technology
- eradicate the menace of lack of or inadequate instructional materials for science teaching
- sensitize both students and teachers that alternative for some of the conventional materials for teaching science are possible
- minimizes abstractness and monotony in teaching science topics
- provide the students with firsthand experience in the use of improvised materials
- save fund for the school and government
- makes science learning interesting to the students

It is pertinent to note however that some factors are to be considered before embarking on improvising a material. Some factors include the cost of production with respect to the available standard material, maintaining the originality of the concept to be taught with the material, simple and not complicated, availability of raw materials locally, etc. Any improvised instructional material must be handy, simple, tangible, concrete (not fragile), safe to use and free of hazard [4].

It is not discouraging however to observe that the idea of improvisation has its critiques by educational researchers on the submission that improvised materials are often rough, unattractive, not reliable and often provide invalid results. [13] observed a slight different in the performance between students taught with standard instructional materials and those taught with improvised materials.

Nigeria, just like any developing countries, has a lot of challenges including her economy. The cost of production of the standard apparatus is high and hence their cost price. Procuring standard apparatus for the teaming science students might be a mirage. Thus, the available standard materials are often not sufficient for the number of students in Nigeria. Since the school could not provide all the materials needed in the laboratories, the science teachers and the students are obliged to make what they can get or construct from locally available raw materials [10]. Improvisation therefore would be the alternative means available for the teacher to provide the sufficient number of apparatus for the students.

Statement of the Problem

Science is an integral part of human life so much that it can be considered as the bedrock of human existence. It is often disheartening to observe however that students' interest in study science seems dwindling daily despite its relevance to nation's growth and development [4,2]. Most feared subject among the sciences is physics which is perceived by most of the students as the most difficult science subject in the school curriculum [12]. No wonder, students performed poorly in physics at the senior School certificate examinations [3]. Factors identified to be responsible for poor performance in science subjects and physics in particular include poor laboratory facilities, under presentation of concepts by the physics teacher, inadequate learning facilities, among others [13].

Purpose of the Study

The intent of the study was to find out whether improvised materials would produce the same experimental results as the standard materials. A hypothetical case of determining the value of acceleration due to gravity was considered.

Research Question

Will improvised materials produce the same results as the standard materials in determining the value of acceleration due to Gravity?

Theoretical Background of Acceleration Due to Gravity

The concept of acceleration due to gravity was bored on the basis that every object on the earth's surface is continuously attracted to the centre of the earth by a constant force. This force of attraction is called the force of gravity or gravitational pull or simply the gravity.

When an object is therefore thrown upwards on the earth's surface, it moves up for a while and latter falls back to the ground. The rate of falling back to the ground is called the acceleration due to gravity. The acceleration due to gravity is often determined by the pendulum bob experiment where the bob is subjected to an oscillatory motion and it's time of oscillation been observed.

Experimentally, it has been established that the period of oscillation of a pendulum bob, the length of the bob and the acceleration due to gravity, g, are related as

$$T = 2\prod \sqrt{l/g}$$

$$T^2 = \frac{4\prod^2 l}{g}$$

$$\rightarrow \quad g = \frac{4\prod^2 l}{T^2}$$

$$g = 4\prod^2 \text{ X Slope} \quad \text{where slope} = l/T^2$$

$$g = 39.488 \text{ x slope}$$

Description of the Apparatus

The instruments for this study were two sets of scientific apparatus, classified as standard and improvised materials, for determining the value of acceleration due to gravity. The standard materials consist of: silver bob, silver retort stand, metal clamp, industrial stop watch, 1metre rule and thread. The improvised materials are: calved round hard stone, wooden retort stand, wooden clamp, heart beat as the clock, locally made 1metre rule and thread.

The standard materials were bought from the scientific equipment stores while the improvised materials were locally prepared. The stone were made by the students while the wooden retort stand, the clamp and the 1metre rule were made by local woodwork artisan under thorough and close supervision by the researcher to ensure precision and accuracy.

Experimental Procedure

The undergraduate students of Basic Science Education in the Faculty of Education, Ekiti State University were divided into two groups, A and B. Group A worked with a set of standard apparatus while group B worked with a set of improvised apparatus. The students were exposed to the experimental process of determining the value of acceleration due to gravity through the pendulum bob method. The write up by the researcher on step-by-step process of carrying out the experiment was given to the two groups to follow while the researcher moved round to monitor the students while performing the experiment. The time for 25 complete oscillations was taken for a given set of lengths of the pendulum bobs (both standard and improvised groups).

Results

Observations from Standard Materials:

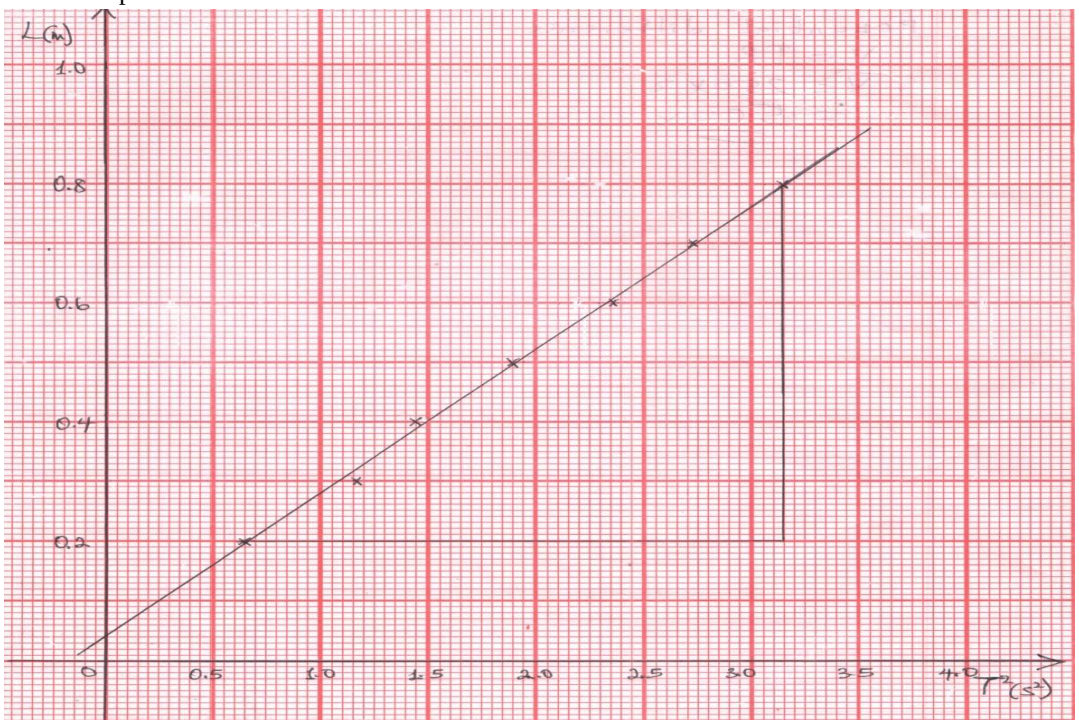
L (cm)	t_1 (s)	t_2 (s)	t average (s)	T (s)	T^2 (s^2)
0.200	20.00	20.20	20.10	0.804	0.6464
0.300	27.10	26.90	27.00	1.080	1.1664
0.400	30.20	30.10	30.15	1.206	1.4544
0.500	34.50	34.50	34.50	1.380	1.9044
0.600	38.60	38.40	38.50	1.540	2.3716
0.700	41.20	41.40	41.30	1.652	2.7291
0.800	44.40	44.40	44.40	1.776	3.1542

Observations from Improvised Materials

L (cm)	t_1 (s)	t_2 (s)	t average (s)	T (s)	T^2 (s^2)
	22.30	22.20	22.25	0.890	0.7921
0.300	22.60	22.80	27.70	1.108	1.2276
0.400	31.50	31.40	31.45	1.258	1.5826
0.500	34.90	35.10	35.00	1.400	1.9600
0.600	39.10	39.20	39.15	1.566	2.7489
0.700	41.50	41.40	41.45	1.658	2.7499
0.800	44.00	43.80	43.90	1.756	3.0835

Graphical Representations of Observations

i. Graph of Observations from Standard Materials

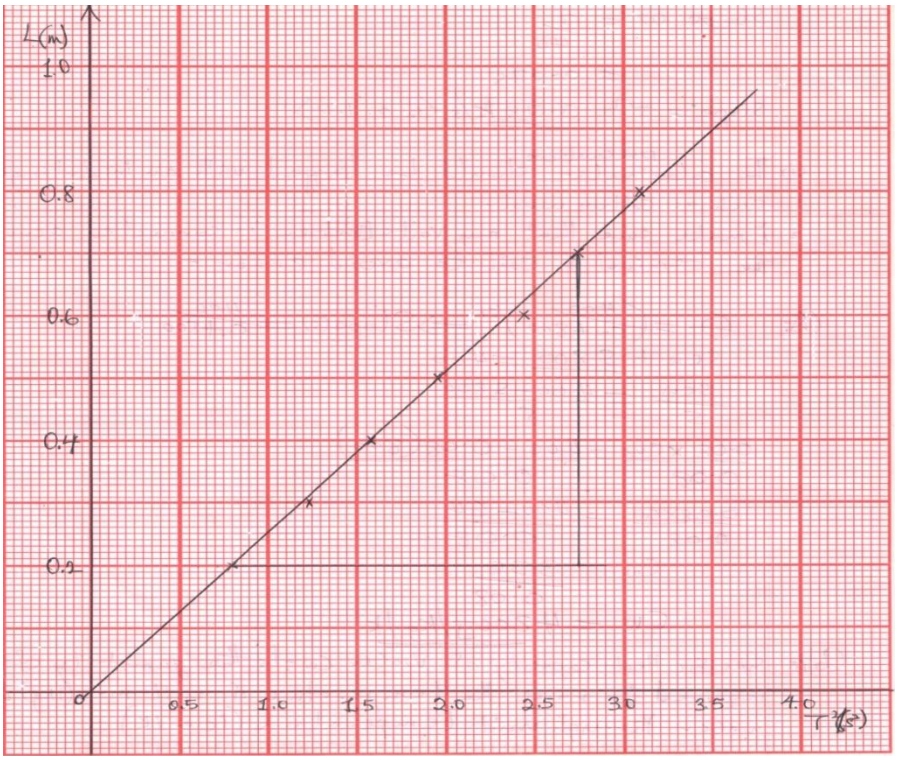


Slope = $\frac{0.80 - 0.20}{3.15 - 0.65}$

= $\frac{0.60}{2.50}$

= 0.240

ii. Graph of Observations from Improvised Materials



Slope $= \frac{0.70 - 0.20}{2.75 - 0.8}$

$= \frac{0.50}{1.95}$

$= 0.256$

The graphical representations of the observations from standard and improvised materials showed the gradient values of 0.240 and 0.256 respectively.

Deductions

For standard materials:

Acceleration due to gravity, g = 39.49 x 0.240

$= 9.477 \approx 9.5\ ms^{-2}$

Also, for improvised materials:

Acceleration due to gravity, g = 39.49 x 0.256

$= 10.108 \approx 10.1\ ms^{-2}$

Thus, from the two sets of materials, the value of acceleration due to gravity is 9.5 ms^{-2} for standard materials and 10.1 ms^{-2} for improvised materials.

Discussion

From the findings of this study, the value of acceleration due to gravity obtained through a set standard materials was 9.5 ms^{-2} while the value through a set of improvised materials was 10.1 ms^{-2}. The established theoretical value of acceleration due to gravity is ≈ 9.8 ms^{-2}. Considering the tolerance level of ±5% (0.49) which gives a range of $9.31 \leq x \leq 10.29$, it is obvious that the values of acceleration due to gravity obtained from both sets of materials fall within the tolerance values. This result justifies the submission of [2] that improvisation of instructional materials is a meaningful attempt towards finding suitable substitute or alternative to conventional science materials. The reason is not farfetched since the improvised materials were carefully made and selected by experts in the field of study for which the materials would be utilized.

Conclusion and Recommendations

It can be concluded from the results of this study that improvised scientific materials are capable of producing the same experimental observations as the standard materials. On this submission, it is therefore recommended that science teachers should cultivate the habit of improving for science apparatus and materials to be used in the laboratory in case the standardized ones are not available or inadequate. The school authority should encourage and support the science teachers morally and financially on any step to improvise for science materials

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