STUDENTS' PERCEPTION ON PHYSICS LABORATORY EQUIPMENT IN THE UNIVERSITY OF SCIENCE AND TECHNOLOGY OF SOUTHERN PHILIPPINES

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ABSTRACT: *The study was conducted to determine the perception of undergraduate students towards the standard and improved physics laboratory equipment in the University of Science and Technology of Southern Philippines (USTP), formerly known as Mindanao University of Science and Technology (MUST). This study adopted the research design of descriptive statistical survey, wherein students-constructed questionnaire was used to gather the necessary responses needed from the students. The sample size was comprised of 322 random students from all colleges. This was established in order to extrapolate a better response of perception towards the standard and improved equipment for kinematics and torque experiments. Kinematics had two set-ups which consisted of stopwatch (standard) and timer (improved). Likewise, the torque experiment consisted of a meter stick with clamp and knife-edged balance (standard) and a hanger (improved). Both set-ups of each experiment were compared. The data were analyzed using the two-way ANOVA, mean and percentage. Findings show that there was a significant difference in the laboratory equipment depending on the user. For kinematics the stopwatch was perceived better to use. For torque experiment the hanger was perceived positively. Overall, the genders of the respondents do not affect their performance (p-values: 0.96, 1.29, and 0.41).*

Keywords: kinematics; torque; physics; laboratory equipment

1. INTRODUCTION

Science education requires schools to have appropriate laboratory equipment/materials to facilitate learning effectively. In every experiment, the laboratory equipment is essential in accurate data gathering [1]. Laboratories may (i) provide virtual and physical investigations which can meet the goals of science courses [2] and (ii) provide an environment for cognitive apprenticeship enhanced by formative assessment [3]. This medium of learning may act as an experimental foundation for the theoretical concepts introduced in the lectures. Laboratory works in coupled with laboratory simulations may likely increase the chance of a positive learning outcome [4]. A better laboratory learning interaction with instructional simulations can help students understand a real system, process, or phenomenon [5].

In a review of the literature, references [6,8] proposed a classification of goals for laboratory instruction in science education:

1. to arouse and maintain interest, attitude, satisfaction, open-mindedness and curiosity in science;
2. to develop creative thinking and problem-solving ability; (3) to promote aspects of scientific thinking and the scientific method (e.g., formulating hypotheses and making assumptions);
3. to develop conceptual understanding and intellectual ability; and
4. to develop practical abilities (e.g., designing and executing investigations, observations, recording data, and analyzing and interpreting results).

References [7,8] summarized the goals of laboratory work in four main areas:

1. to foster knowledge of the human enterprise of science so as to enhance student intellectual and aesthetic understanding;
2. to foster science inquiry skills that can transfer to other spheres of problem solving;
3. to help the student appreciate and in part emulate the role of the scientist; and
4. to help the student grow both in appreciation of the orderliness of scientific knowledge and also in understanding the tentative nature of scientific theories and models.

Physics as a college course requirement is offered in the University of Science and Technology of Southern Philippines (USTP) prior to K-12 implementation. However, the extent of this learning outcomes cited from [6, 7,8] were not assessed in the college physics laboratory courses. It is with this purpose that the study was conducted to locally determine the perception of students studying physics with the use of the standard and improved physics laboratory equipment. The researchers also determined which of the Physics laboratory equipment was perceived by the students (both genders) likely improved their performance.

2. MATERIALS AND METHODS

2.1 Framework

Laboratories have been found to be at the workplace where practical activities are conducted to enhance science concept and theories [9,10]. It is a primary vehicle for promoting formal reasoning skill and students understanding, thereby enhancing desired learning for students [11]. The changes of equipment may affect the performance of students due to the prototype of the equipment. Thus, this study aims to know the perception of students in USTP on the standard and improved laboratory equipment in physics. In this study, the perception of students were assessed to know if their perception will depend on the type of equipment (Standard or Improved); and

the performance of the students were examined if it was affected by their gender (Male or Female).

Table (1) Conceptual Framework of the Study

Independent Variable	Dependent Variable
A. Equipment *1. Standard* 1.1 Kinematics (Stopwatch) 1.2 Torque (Meter stick with clamp and knife-edged balance) *2. Improved* 2.1 Kinematics (Timer) 2.2 Torque (Hanger) B. Gender 1. Female 2. Male	A. Students' perception a. Strongly Agree (SA) b. Agree (A) c. Disagree (D) d. Strongly Disagree (SD) B. Students' performance a. Easy to use b. Time consuming c. Require of orientation before experiment d. Aids knowledge in lectures

2.2 Research Design

This study was descriptive-comparative type of research. It was descriptive because the responses of college students towards the standard and improved laboratory equipment were determined. It was also comparative because standard and improved equipment were compared according to students' perception, and performance with regards to their gender.

2.3 Hypothesis

This research was conducted in USTP campus during the first semester of S.Y. 2016-2017. The following null hypotheses were formulated and tested at p=0.05:

1. There is no significant difference between the standard laboratory equipment and the improved laboratory equipment according to the perception of students.
2. There is no significant difference in the performance of students in laboratory experiments according to gender.

2.4 Respondents

The group computed the sample size by Slovin's formula and obtained a sample size of 322. The sample was composed of students from all colleges: College of Engineering and Architecture (CEA), College of Arts of Sciences (CAS), College of Industrial and Information Technology (CIIT), and College of Policies Studies, Education and Management (CPSEM), who were able to use the standard equipment and students who were able to use the improved equipment in Physics 10. These were the colleges of the former Mindanao University of Science and Technology (MUST). The respondents were asked about their perception towards experiments on Motion of Free Falling Body (1-D Kinematics) and Torque. See Table 2 and Figure 1.

Table (2) Demographics of the respondents

College	Courses	Gender	Age	No. of Respon-dents
College of Arts and Sciences	BS Applied Physical Sciences	Male	17-18	8
		Female	17-18	8
	BS Chemistry	Male	17-18	8
		Female	17-18	8
	BS Applied Mathematics	Male	17-18	8
		Female	17-18	8
	BS Environmental Science and Technology	Male	17-18	8
		Female	17-18	8
	BS Food Science and Technology	Male	17-18	8
		Female	17-18	8
College of Engineering and Architecture	BS Civil Engineering	Male	17-18	10
		Female	17-18	10
	BS Mechanical Engineering	Male	17-18	10
		Female	17-18	10
	BS Computer Engineering	Male	17-18	10
		Female	17-18	10
	BS Electrical Engineering	Male	17-18	10
		Female	17-18	10
College of Industrial and Information Technology	BS Information Technology	Male	17-18	8
		Female	17-18	8
	BS Automotive Mechanical Technology	Male	17-18	8
		Female	17-18	8
	BS Electronics and Communication Technology	Male	17-18	8
		Female	17-18	8
	BS Electrical Technology and Management	Male	17-18	8
		Female	17-18	8
College of Policies Studies, Education and Management	BS Education-Physical Sciences	Male	17-18	10
		Female	17-18	10
	BS Education-Mathematics	Male	17-18	10
		Female	17-18	10
	BSED (Technology and Livelihood Education)	Male	17-18	10
		Female	17-18	10
	BEED Special Education	Male	17-18	10
		Female	17-18	10
Total number of respondents				322

2.5 Survey Questionnaire

The research instrument used in this study was a student-constructed questionnaire (SCQ). It contains 4 items question for both standard and improved equipment which have 4 option choices. Strongly Agree (SA), Agree (A), Strongly Disagree (SD), and Disagree (D). The respondents were made to select what is preferable for them from the limited set of options provided. See Figure 1.

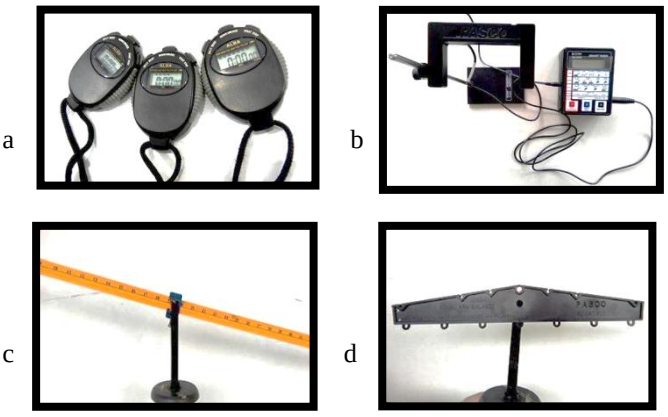

Fig (1) Kinematics experiment: (a) stopwatch; (c) timer and torque experiment: c) meter stick with clamp and knife-edged balance; (b) hanger

2.6 Conduct of Survey

The questionnaires were randomly given to students in USTP. The questionnaire was administered to them to determine their perception and they were also collected immediately to avoid alteration.

2.7 Data Analyses

Mean, percentage, and two-way ANOVA were used to test the hypothesis in this study. The obtained data were computed and used in testing the hypotheses at 0.05 level of significance. This level of significance set the basis for rejecting or accepting each of the hypotheses.

3. RESULTS AND DISCUSSION

3.1 Overall students' perception on kinematics experiments

For question number 1: "It is easy to use.", 90 strongly agreed, 57 agreed, 12 disagreed, and 2 strongly disagreed for stopwatch; and 92 strongly agreed, 58 agreed, 6 disagreed, and 5 strongly disagreed for timer. For question number 2: "Using this equipment is time consuming.", 58 strongly agreed, 79 agreed, 17 disagreed, and 7 strongly disagreed for stopwatch; and 52 strongly agreed, 61 agreed, 29 disagreed, and 19 strongly disagreed for timer. The respondents chose stopwatch as the equipment that is time consuming during experiment.

For the question number 3: "Orientation in using this equipment must be done before doing the experiment.", 52 strongly agreed, 61 agreed, 21 disagreed, and 27 strongly disagreed for stopwatch; and 70 strongly agreed, 61 agreed, 8 disagreed, and 22 strongly disagreed for timer. The respondents chose timer as the equipment that needs an orientation/lecture before doing the experiment. Laboratory instruction when using improved equipment is necessary to help student think about the instructional episode in such a way as to evaluate their understanding in relation to what is experienced [12].

Table (3) Students' perception on standard and improved equipment in Kinematics experiment

Statements	Stopwatch				Timer			
	SA	A	D	SD	SA	A	D	SD
It is easy to use.	90	57	12	2	92	58	6	5
Using this equipment is time consuming.	58	79	17	7	52	61	29	19
Orientation in using this equipment must be done before doing the experiment.	52	61	21	27	70	61	8	22
This equipment aids my knowledge in Kinematics experiment.	67	76	7	11	68	77	9	7

Legend: SA-strongly agree; A-agree; D-disagree; SD-strongly disagree

For question number 4: "This equipment aids my knowledge about kinematics.", 67 strongly agreed, 76 agreed, 7 disagreed, and 11 strongly disagreed for stopwatch; and 68 strongly agreed, 77 agreed, 9 disagreed, and 7 strongly disagreed for timer. The respondents chose timer as the equipment that aids their knowledge in kinematics experiment than the stopwatch. Overall the highly perceived on the Kinematics experiment was the timer, owing accessibility and recall convenience.

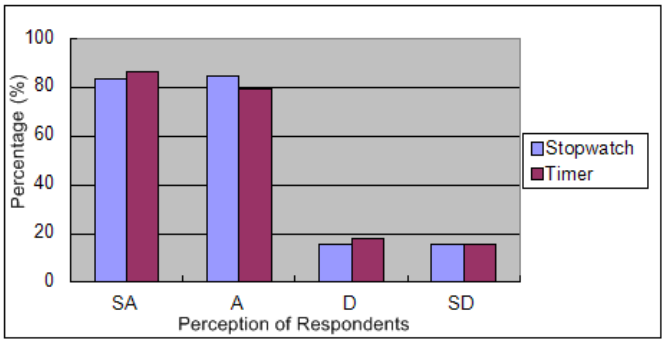

Figure (2) Overall percentage of students' perception per parameters for Kinematics experiment

3.2 Overall students' perception on torque experiments

For question number 1: "It is easy to use.", 73 strongly agreed, 66 agreed, 17 disagreed, and 5 strongly disagreed for meter stick with clamp and knife-edged balance; and 75 strongly agreed, 63 agreed, 19 disagreed, and 4 strongly disagreed for hanger. The respondents chose hanger as the equipment that is easier to use in the experiment. Primary reason can be attributed to high quality of improved materials [13].

For question number 2: "Using this equipment is time consuming.", 80 strongly agreed, 33 agreed, 22 disagreed, and 26 strongly disagreed for a meter stick with clamp and knife-edged balance; and 43 strongly agreed, 58 agreed, 31 disagreed, and 29 strongly disagreed for hanger. The respondents perceived the meter stick with clamp and knife-edged balance as the time consuming equipment during the experiment.

For the question number 3: "Orientation in using this equipment must be done before doing the experiment.", 63 strongly agreed, 81 agreed, 13 disagreed, and 13 strongly disagreed for meter stick with clamp and knife-edged balance; and 63 strongly agreed, 69 agreed, 13 disagreed, and 16 strongly disagreed for hanger. The respondents perceived the meter stick with clamp and knife-edged balance as the equipment to better aid their laboratory work under the torque experiment.

Table (4) Students' perception on standard and improved equipment in Torque experiment

Statements	Meter stick with clamp and knife-edged balance				Hanger			
	SA	A	D	SD	SA	A	D	SD
It is easy to use.	73	66	17	5	75	63	19	4
Using this equipment is time consuming.	80	33	22	26	43	58	31	29
Orientation in using this equipment must be done before doing the experiment.	63	72	13	13	63	69	13	16
This equipment aids my knowledge in Kinematics experiment.	71	79	4	67	67	72	19	3

Legend: SA-strongly agree; A-agree; D-disagree; SD-strongly disagree

For question number 4: "This equipment aids my knowledge about torque.", 71 strongly agreed, 79 agreed, 4 disagreed, and 7 strongly disagreed for meter stick with clamp and knife-edged balance; and 67 strongly agreed, 72 agreed, 19 disagreed, and 3 strongly disagreed for hanger aids respondent's knowledge in kinematics experiment. The respondents perceived the meter stick with clamp and knife-edged balance as the equipment that aids their knowledge in torque experiment. Practical activities using this equipment enhance the understanding of physics theory and phenomena [14].

The overall responses of the students for the Torque experiment showed favorable perception towards the use of meter stick with clamp and knife-edged balance (see Figure 3). Students had different perceptions on the equipment they had used during experiments. The importance of experiment in school is that it provides learners the opportunities to use scientific equipment to develop basic manipulative skills and practice investigative or inquiry activities and develop problem solving attitudes needed for future work in science [15].

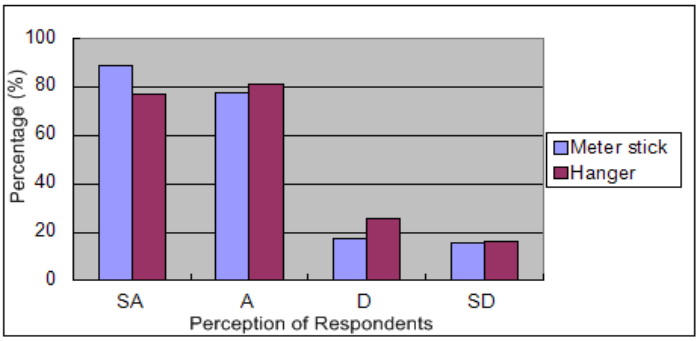

Figure (3) Overall percentage of students' perception per parameters for Torque experiment

3.3 Students' performance based on gender

Two-way ANOVA was used in determining if the performances of students during experiments, according to their perception, differ with respect to gender. Three sub-hypotheses were formulated and tested to determine if these were accepted or rejected.

1. There is no significant effect from the gender factor on the performance of students.
2. There is no significant effect from the perception factor on the performance of students.
3. The interaction between gender and perception do not affect the performance of students.

Table 5. ANOVA results on the performance of students (tested at p=0.05)

Source of Variation	P value	F critical	Decision
Gender	0.96	5.3177	Accept
Perception	1.29	4.0662	Accept
Gender x Perception	0.41	4.0662	Accept

The calculated P-values for gender factor, perception factor, and its interaction are greater than p=0.05, thus the gender and perception do not affect the performance of students in their experiments. These results agree with the findings of [8,16,17,19,20] that students' performance is not determined by gender in terms of the interaction of gender and treatment on students' academic achievement.

4. CONCLUSIONS

The present findings showed that there is a significant difference on the laboratory equipment and it is dependent on the user. The equipment that has the largest choice on kinematics experiment is the stopwatch, and on torque experiment is the hanger. The ANOVA results shows that gender have no effects on the performance of students. Overall, laboratory equipment is not the basis for learning yet it helps students to easily visualize and understand physics theories. The improvement on the laboratory equipment is

beneficial for students for them to be exposed on new inventions and technologies, yet it needs a proper guidance and instruction for them to cope immediately.

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