Enriched Laboratory Experiments with Interactive Simulation

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ABSTRACT – Mechanical engineering syllabus contain compulsory laboratory experiments because the development and application of theories used to rest only on real experiments. The three pillars of science maps state that students need to validate the theory through real experiments and then do the verification by using computational experiments. In this paper, PhET interactive simulation which is stand for "Physics Education Technology" was used to help students to verify the lab experiment. The simulation can be used as post practical to enhance student understanding after real experiment.

1. INTRODUCTION

Engineering education emphasizes on practices in laboratory and is incomplete without laboratory practice. The overall goal of engineering education is to prepare students to practice engineering and in particular to deal with the nature of problems faced by the society [1]. And laboratory experiences also provide opportunities for students to interact directly with the material world (or with data drawn from the material world), using the tools, data collection techniques, models, and theories of science [2].

Even there are lot of benefit that students can gain from laboratory experiment, there still lacking because of limited time, limited apparatuses or the damage of the apparatuses. Sometimes these experiments are too hard, too dangerous and too expensive to carry out.

To overcome this situation, the distribution of student learning time was designed to fulfil this lacking. The time allocated for independent learning are 7 hours for student to enrich their practical ability.

Figure 2.1 shows the three pillars of science maps that have been used in this study. This paper recommends on how to improve students understanding from the theory they have learned in class and what they have practiced on real experiments at the laboratory.

Literature shown that there are three types of educational laboratories in engineering education [3, 4]:

(i) Hands-on laboratory with real instruments;
(ii) Simulation or virtual laboratory; and
(iii) Remote or distributed learning laboratory

This paper has proposed to use interactive simulation to help student understanding after laboratory experiment session.

2. METHODOLOGY

Figure 2.1 shows the three pillars of science maps that have been used in this study [5].

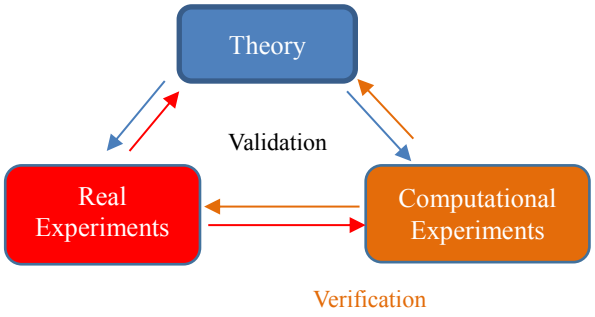

Figure 2.1 Three pillars of science maps [5]

Friction is one of the topics that must be studied by the Mechanical Engineering program students. Students need to do the laboratory experiments to validate what they have learned before. They then need to do calculation by referring to the theory taught earlier.

For verification purposes, students need to conduct computational experiments by using interactive simulation, for example by PhET interactive simulation developed by the University of Colorado [6].

3. RESULTS AND DISCUSSION

3.1 Theory Validation

Given example:-
Material = Steel
Mass of object = 200 kg
Coefficient of friction, $\mu = 0.3$
Hence;

Normal force, $N = mg$ (1)
Normal force, $N = (200 * 9.8)$
$= \mathbf{1960\ N}$

Friction force, $F_f = \mu N$ (2)
Friction force, $Ff = (0.3*1960)$
$= \mathbf{588N}$

3.2 Computational Experiments Verification

After the laboratory experiments, students can enhance their knowledge of frictional force with verification using interactive simulation. Figure 3.1

shows the object applied force have the same value with frictional force, **588N**. Thus, the object is still on static condition.

Meanwhile Figure 3.2 shows the object start moving because the applied force showed more than the frictional force, **588.1 N**.

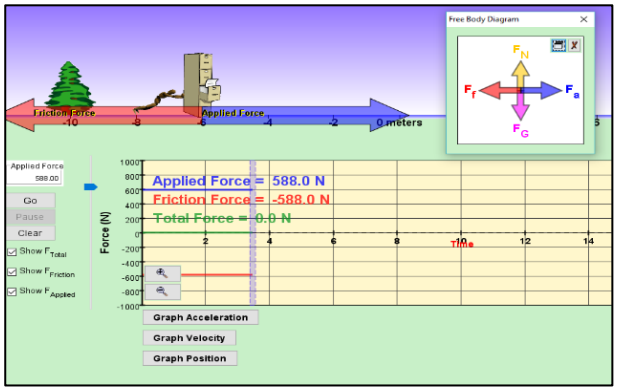

Figure 3.1 Applied Force same value with frictional force, 588N

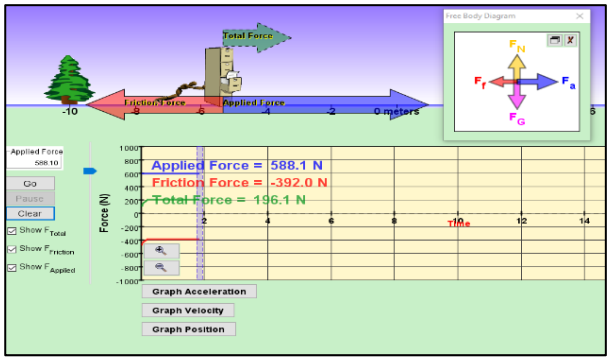

Figure 3.2 Applied Force more than frictional force, 588.1N

4. CONCLUSIONS

Laboratory experiments are compulsory which enable students to develop their experimental skills, ability to work in teams, responsible for their own results and collected data, and also to anticipate the findings that already described in theory. However, not all of the students can grab the experience and enhance their knowledge about what they had practice at the laboratory.

It is recommended that the computational experiments can be used to do the verification. Students can spend their independent learning time by doing the simulation to enrich their understanding of the experiment.

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