Developing Learning Activities on Moment of Inertia for Grade 11 Students

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Abstract

The sets of learning activities on moment of inertia and applications for grade 11 students were designed and created and then used for active learning activities. The activities include the experiment of the relations between linear and angular velocities, moment of inertia and related quantities, inquiry activity on rolling of objects with different shapes and radii, and law of angular momentum conservation. The results show that the students understand the concept and students' attitude towards Physics is increased.

Keyword : Learning activity, Moment of Inertia, Application

Introduction

The process of teaching science focuses on students in order that the students learn and understand by constructing their knowledge. In this way, the students gain knowledge and build their scientific skills as well as social skills.

The concept of moment inertia is hard to understand for grade 11 students. It is a new and abstract concept. The text book by the institute for the promotion of teaching science and technology (IPST) does not provide enough learning activities [1]. In this work, thus, we propose developing learning activities on moment of inertia for grade 11 students to foster students so that the students can construct their own knowledge by doing learning activities such as experiments and hands-on experience.

Materials and Methods

The design of the apparatus for moment of inertia experiment is shown in Fig. 1. The real set up of the apparatus is shown in Fig. 2.

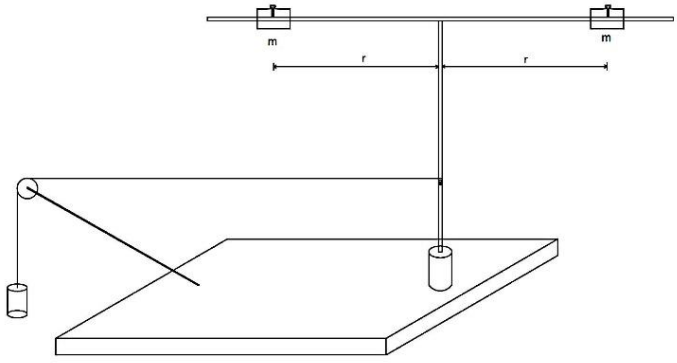

Figure 1. The diagram of the designed apparatus.

Figure 2. The real set up of the experiment for moment of inertia.

The purpose of the experiment is to construct students' concept of moment of inertia. In the first experiment, the students will carry out an experiment to verify that moment of inertia varies as the square of radius ($I \propto r^2$). In the second experiment, the students will perform an experiment to show that moment of inertia is proportional to mass ($I \propto m$).

The third experiment will be application of moment of inertia. The students perform a series of experiments using an inquiry method of teaching[2]. The inquiry question is which objects (hollow cylindrical, solid cylindrical, and solid sphere) will reach the lower end of the incline plane fastest: 1) does it depend on mass? 2) does it depend on radius? or 3) does it depend on shape? These series of experiment intend to show that the kinetic energy of rolling objects consist of rotational and translational parts. The rotational kinetic energy is $I = kmr^2$ and k depends on the shape of an object. For example, k's are 1, 1/2, and 2/5 for hollow cylindrical, solid cylindrical, and solid sphere, respectively. The fastest is a solid sphere ball because of the sphere has smallest fraction, k or smallest fraction k of moment of inertia.

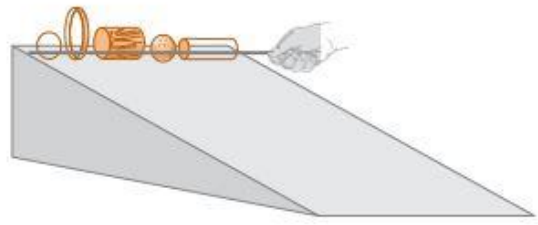

Figure 3. Bodies with different shapes roll down a ramp[3].

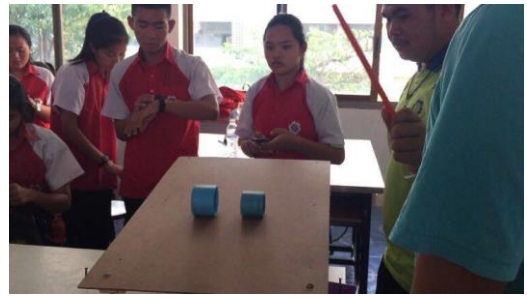

Figure 4. Rolling of objects on an inclined plane.

The fourth experiment is demonstration the law of angular momentum as shown in Fig. 5. This demonstration show that the shorter radius of rotation, the smaller of moment of inertia, leading to the faster of the rotation.

Figure 5. The demonstration the law of angular momentum by grade 11 students

Results and Discussion

The apparatus has been used in grade 11 Physics classroom of Kudkhaopun Witthaya School. The students were excited and happy to learn. They have a chance to work in a group of 5 students. They have learned Physics by doing experiments, develop scientific skills, e.g., measurement, collecting data, graphing, analyzing data, and drawing a conclusion. They also have gained social skills such as group discussion, working together, and communication. The average score was increased with statistical significance at .05 levels as shown in table 1.

Table 1: Mean score, average normalized gains, and t-statistics on the pre-test and post-test.

Score	Number of students	Full score (20)		SD	t
		mean	percent		
pretest	30	6.57	32.83	1.57	25.36*
posttest	30	14.70	73.50	1.76	

$t_{\alpha=.05,df\ 29} = 1.69$

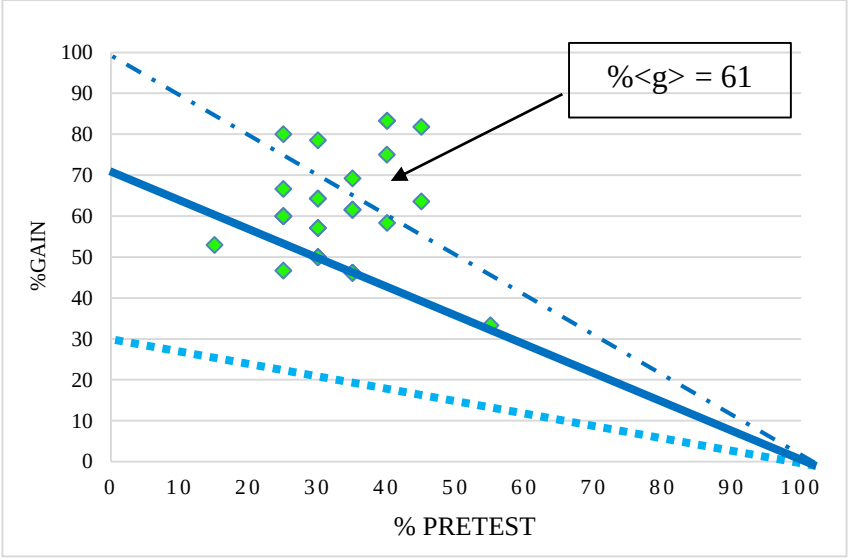

Figure 6. The relation between % Pretest and %Gain of the students.

The normalized gain, <g>, a measure of the advancement of students' learning in scores between pre-test and post-test, was expressed as a fraction of the range of possible score increase and was also calculated by[4].,

$$< g > = \frac{\%posttest - \% pretest}{100\% - \%pretest}$$

and

<g> < 0.3 is low gain,

0.3 < <g> < 0.7 is medium gain,

<g> ≥ 0.7 is high gain.

The average normalized gains were 0.61 which is considered as medium gain. No student is in low gain. The scores of 24 students are in medium gain and 6 students are in high gain.

Conclusions

We have developed the apparatus for learning through inquiry and active learning methods. The learning activities helped to develop students' concepts of moment of inertia, angular momentum, and rolling. The activities also promote abilities of the student in analytical thinking on moment of inertia for the students. The students participated in Physics classroom enthusiastically. They developed scientific skills and social skills at the same time.

Acknowledgments

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