3rd WCPE World Conference on Physics Education
Hanoi, Vietnam, 13 - 17 December 2021
3RD WORLD CONFERENCE ON PHYSICS EDUCATION
Innovating physics education: From research to practice

Contribution ID: **114** Type: **Presentations in Wroclaw**

University students understanding of the moment of inertia in a rotating rigid body

Thursday, December 16, 2021 11:00 AM (20 minutes)

University students understanding of the moment of inertia in a rotating rigid body
Paulo Sarriugarte, Peio Garcia-Goiricelaya, Jenaro Guisasola & Kristina Zuza
Donostia Physics Education Research Group, Applied Physics Department, University of the Basque Country (UPV/EHU), Spain

Abstract. It is well known that the comprehension of the moment of inertia is essential to understand any phenomenon of the rotation of a rigid body. The objective of our study is to inquire into the conceptions of university students when they explain the role of the moment of inertia in phenomena of rotation of a rigid body about a fixed axis. We have designed an open-ended questionnaire for students in a calculus-based introductory physics course. The questions were designed following an epistemological analysis in order to raise the key concepts needed to understand the moment of inertia of a rigid body properly. In this study, we intend to find different ways in which students interpret significant aspects of the moment of inertia, through the analysis and understanding of students' explanations. We will present a number of the questions and results.

Introduction

In many undergraduate physics courses, the program begins with Mechanics because most of the subjects are a review of physics in High School courses and it is considered that the students will not have significant difficulties in their learning. However, understanding the kinematics and dynamics of circular motion is difficult for students. The literature has shown that high school and university students present some difficulties in understanding particles' rotational movement. The research reveals that a significant amount of students think that a particle describing a uniform circular motion does not have acceleration, that no force is needed to produce circular motion and they consider centrifugal forces as "real" even for an inertial frame of reference [1]. Students show difficulties distinguishing between linear and angular acceleration and between linear and angular velocity. Moreover, they show difficulties distinguishing between centripetal force and acceleration [2,3]. We expect that the gap in the comprehension of the concepts grows up when the particle is substituted by a rigid body.

The objective of our study is to analyze how first year university students recognize and apply the concepts of moment of inertia for a rotating rigid body. The aim is to relate the ability of students to apply this concept with their understanding of it. We want to detect students' comprehension difficulties when learning the concepts of moment of inertia at undergraduate physics courses. The motivation behind this study is to know the level of understanding that students have after instruction in introductory physics course at University. This knowledge constitutes a relevant contribution when designing the didactic material to be implemented in lectures.

Experimental design and methodology

We conducted a study with 82 students from first course of engineering of the University of Basque Country (UPV/EHU). All students take two physics courses involving topics on mechanics electromagnetism during postcompulsory education (16–18 years old). The students were randomly distributed among the first year engineering groups. All students were finishing the first semester of introductory physics in the first year of engineering We gave students an open-ended questionnaire (8 questions) after they had studied the rigid body rotation, where rotation was considered to be around a fixed axis in space.

Regarding the validation of questionnaire, once the questionnaire had been prepared, three professors. They concluded that the objectives of each question were clear but suggested some changes to the wording of two questions, which were made by the authors. Moreover, we carried out a draft test with 25 first-year course students, which confirmed that students had no problem understanding how the questions were formulated. Finally, the questions were included in the first-year students' test in the form of a post-test for first third-year students who had already completed the semesters of Mechanic.

Findings

We analyzed data with a phenomenographic [4] qualitative method, considering the categories that emerge

based on the students' approach to each question. The categorization process was validated by three researchers, and the classification of students' answers into categories was supported by Cohen's kappa (κ = 0.92).
We found that around 45% of students have a good declarative knowledge about of moment of inertia in a rotating rigid body around a fixed axis but we also found they have diferent difficulties. Around 40% of students do an incorrect analysis of the variables included in the deficintion of the moment of inertia for particles (I=Σ_i⊠m_i r_i^2) or they do the calculation based on a functional reduction regarding only m or r.
When we ask about the angular acceleration showing two cylinders (one solid and onw hollow) with the same mass and radius while the same torque is applied upon them, we see that students around 25% of students apply the Newton's second law for rotation but the don't really undertand the relation of the angular acceleration with the mass distribution. There is another 15% of students that claims that greater moment of inertia implies a greater angular acceleration.

References

J. Klammer, An overview of techniques for identifying, acknowledging and overcoming alternative conceptions in physics education, alternative conceptions, in physics, 1997-98 Klingenstein Project Paper (Teachers Collage, Columbia University. 1998
I. Phil, University Students´ Alternative Conceptions On Circular Motion. International Journal of Scientific and Technology research, 5, 25 (2016)
P. Searle, Circular motion concepts of first year engineering students. Research in Science Education, 15(1), 140 (1985).
F. Marton, and S. Booth, Learning and awareness. (Mahwah, NJ: Lawrence Erlbaum Associates Publishers. 1997)

Primary authors: Dr GUISASOLA, Jenaro (UPV/EHU); Dr ZUZA, Kristina (UPV/EHU (Applied Physics Department)); Dr SARRIUGARTE, Paulo (UPV/EHU); Dr GARCIA-GOIRICELAYA, Peio (UPV/EHU)

Presenter: Dr ZUZA, Kristina (UPV/EHU (Applied Physics Department))

Session Classification: Parallel 10 - Wroclaw

Track Classification: 12. University Physics: research and good practices