GAVIN PUBLISHERS

Educational Research Applications

Grosu FD, et al. Educ Res Appl: ERCA-121.

DOI: 10.29011/2575-7032/100021

Review Article

The Driven Spinning Top: Much Fun and Much Science

Florin D Grosu[1], Alina Rapa[2], Ioan N Grosu[3,4*]

[1]Faculty of Medicine, Lucian Blaga University of Sibiu, Romania

[2]ACP Department, Kwantlen Polytechnic University, Metro Vancouver, Canada

[3]Department of Chemistry, Alexandra Ioan Cuza University, Iasi, Romania

[4]Medical Bioengineering, Grigore T Popa University of Medicine and Pharmacy, Iasi, Romania

[*]**Corresponding author:** Ioan N Grosu, Department of Chemistry, Alexandra Ioan Cuza University, Iasi, Romania. Tel: + 40726024330; Email: ioan.grosu@chem.uaic.ro

Citation: Grosu FD, Rapa A, Grosu IN (2017) The Driven Spinning Top: Much Fun and Much Science. Educ Res Appl: ERCA-121. DOI: 10.29011/2575-7032/100021

Received Date: 15 May, 2017; **Accepted Date:** 02 June, 2017; **Published Date:** 09 June, 2017

Abstract

Using 2 permanent magnets any Spinning Top (ST) can be changed to be controllable. The new Driven Spinning Top (DST) is qualitatively superior to the classical ST. Construction details are given and 2 games are suggested. Rotational motion, precession motion, Bernoulli law can be easier understood by playing with DST. It is magic, interactive, educative, scientific, improves patience, practical skills, coordination hand-eye and offers 3 new technical solutions and can trigger new technical ideas.

Introduction

Rotational motion is a distinct chapter of Mechanics. For a deep understanding, the knowledge gained from experiments are very important. There are many machines driven by powerful motors that use rotation but we cannot let children to deal with them because it is risk of accidents. On the other hand, children learn better and easier when they do experiments unsupervised [1]. They communicate, contradict, discuss, debate even "Fight" with arguments but at the end they have to accept what is obvious. Gaining deep and broad understanding is not a smooth process: you are happy that you got the point but after a while you can be the pray of a doubt and so on.

Spinning Top (ST) has been and yet it is and probably will be in the future a much beloved toy. It is known all over the world and children of different countries know how to play it.; even adults like to have one more attempt that reminds nostalgic times of the childhood. Its magic comes from the fact that it keeps a vertical position when it is in rotation but when rotation ceases it lays on a side (as expected). Without rotation, vertical position is an unstable equilibrium. This situation is changed with rotation. ST is the only toy that shows this change of the behaviour and this is why it looks like magic. Toy industry offers a great variety of STs in terms of shapes, dimensions, colours and materials used. They are launched by using 3 fingers and the rotation lasts 15-20 seconds or using launchers when rotation lasts 40-50 seconds. In spite of their diversity all STs have an annoying defect: they are all uncontrollable. It means that once launched we cannot determine it to move in a desired direction. If we touch it, this is equivalent with a friction torque that will impede rotation or it will jump in an unexpected direction.

The paper is organized as follows. Section 2 presents the new toy and didactic device Driven Spinning Top (DST). A classical ST can be turned controllable by using 2 permanent magnets. The benefits of this novelty are presented in Sec. 3. Section 4. contains the preliminary results that are obtained on school population.

The Driven Spinning Top (DST)

Recently ST has been modified using two permanent magnets [2,3]. One small cylindrical magnet is placed on the axis of the ST, at its top. The 2nd magnet, bigger, is held in hand above the ST at 2-3 cm. By moving 2nd magnet slowly (1-2 mm/second) the ST follows it. It means that the ST can be driven horizontally. The new Driven Spinning Top (DST) is qualitatively superior to the classical ST. The driving of the DST is a new technical solution concerning all toys and devices around us. The driving is possible because the interaction (attraction) between 2 magnets does not

introduce any torque and the rotation is conserved. The physics of the DST has been presented at Hands-on Science Conference [4,5]. So, in principle, any ST can be transformed in a DST by putting a small magnet on its axis. The interest is to have a DST that rotates as long as possible. To achieve this, we made other improvements. Inside the body of the ST a hollow cylinder of stainless steel assures a larger moment of inertia that means a longer time of rotation. At the bottom of the ST an iron ball is placed (this helps to have a small friction and helps to have a chain of rotating tops, see below). Above the 1st magnet on the axis a small iron ball is put. This helps to have rotation even when the two magnets stick together with this ball between them. All these technical details are presented in (Figure 1).

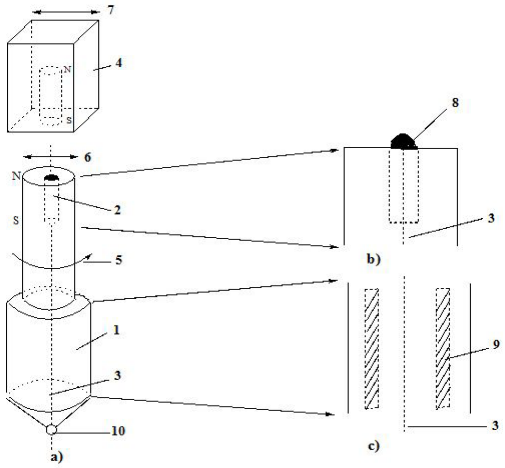

Figure 1: Axial Section of the DST. **1**-1st Magnet, **2**-2nd Magnet, **3**-Wood, **4**-Axis, **5**-Iron Ball, **6**-Rotation,**7**-Move of the 2nd Magnet, **8**-Move of the ST, **9**-Iron Ball.

(Figure 2) shows the 2nd new technical solution: when the 2 magnets stick together with the ball between them, the ST keeps rotating. It works like this [3,6].

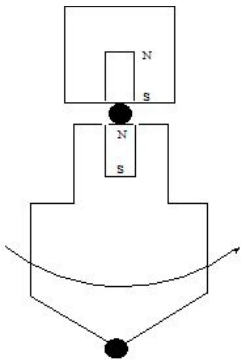

Figure 2: The 2 Magnets are stuck together with the ball between them. ST keeps rotating.

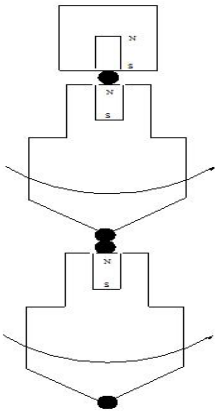

Figure 3: Chain of rotating STs.

If we have two STs in rotation and we lift one of them like in (Figure 2) and let its bottom on the top of the 2nd ST then the 2 STs will be connected and we can lift them like in (Figure 3). Figure 3 shows the 3rd new technical solution: a chain of STs in rotation.

Using the DST presented at least 2 games can be proposed. One is to drive the DST along an itinerary marked with points (Figure 4). Starting from center the DST is guided to the semicircle with number 1 and 1 point has been gained and so on. Another one is to play TOPBALL (in analogy with football, volleyball, basketball);2 players (each with a DST) hit a glass ball toward the opponent's

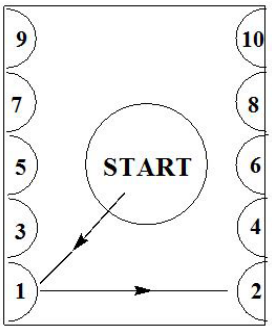

Figure 4: A plastified A4 sheet of paper that helps to play visiting rectangles.

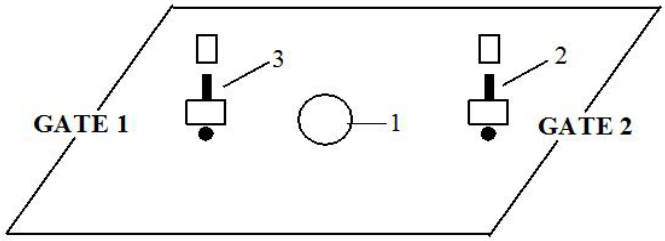

Figure 5: A plastified sheet of paper with 2 gates marked helps to play TOPBALL.

Benefits of the Driven Spinning Top

There are 2 types of benefits: fun (as a toy) and science (like a didactic device). Students of all ages enjoy to play DST. By playing they experience, they feel the vibrations of the 2nd magnet in their hands. DST is magic, interactive, educative, scientific, improves patience, practical skills, offers 3 technical solutions. The 1st game (Figure 4) can measure the sum of several skills (launching, driving, keeping a distance of 2-3 cm between 2 magnets, having patience to move it slowly with 1-2 mm/second). So, this game can be used like a quantitative method of measurement of these skills. Also, it can be used to monitor the progress of the skills by exercising. The 2nd game (Figure 5) also: the score is a very quantitative result like in football.

By playing with DST students have a great chance to understand better and easier some Physics and some Engineering. Rotational motion can be well understood and in a very safely manner. Even if for primary school students the law of conservation of angular momentum is rather difficult to teach but they will have a feeling of it: if we have the case of (Figure 2) and we shake the hand the ST will be released and it will continue to rotate. Later can be explained that no torque was involved and this is why the rotation is not disturbed. If 2 DSTs are in rotation we can manage to have them close enough (8-10 mm apart) and from this distance we can observe that they attract each other, collide and run away one from another. Attraction is because of Bernoulli law from fluidics and repulsion is because of collision. This is observed in game 2 (Figure 5).

A great point is precession motion. When rotation is nearly stopped we observe a precession. But this is not so important. If we hold the 2nd magnet obliquely above the ST then a precession motion is observed. It means that the precession is obtained when an object with angular momentum and magnetic moment is subject to an external magnetic field. This is the case for protons in external magnetic field. Nuclear Magnetic Resonance (NMR) is obtained when an external electromagnetic signal is pumped and protons change one orientation to another one against external magnetic field constant. NMR is the core physical phenomenon at Magnetic Resonance Imaging(MRI) and functional MRI (fMRI) that are great noninvasive tools for physics, chemistry, biology and medicine (fMRI tomograph). From here can be seen the multidisciplinary use of NMR. We mention here that the precession of nuclear spin around external magnetic field is not intuitive at all in all handbooks of physics and chemistry. Playing with DST helps to understand easier and deeper NMR.

In the last 15 years a new scientific branch appeared: Spintronics (http://www.spintronics-info.com). It deals with spins up and down and aims to build even quicker computers and other devices (including medical ones) along with all nanotechnology achievements. Finally, we note that all celestial bodies are STs and at the atomic level particles have spin (angular momentum) and magnetic moment it means that they are DSTs.

Discussions

The technology is moving at a pace we never imagined before. The digital era is here everywhere. Children (even very kids) enjoy using it. The Education have to adapt itself and to adopt what digital facilities offer. There is here a great lesson we learn. When there is an interest no difficulty can impede the students to learn. The mobile's menu contains a lot of knowledge. If this amount of knowledge could not be of their much interest it would need one semester of teaching and a lot of complains and sighs of a yawning audience. While scientific literature presents research results on students' attitude to science [7,8] and primary teachers' attitude toward science [9] it seems that no efforts have been spent to push children to learn mobile's menu. The only answer is that they have interest. The Science Education should use this wave of interest in its interest. There are some results to use smartphones in physics laboratory [10,11].

On the other hand, digital devices are not everything or in other words touching screens and clicking on the mouse is not a balanced education. Digital devices help to manage information, communication but classical sciences like Mechanics or Thermodynamics cannot be replaced. The ideal would be to make all sciences as interesting as smartphones. This is not possible but efforts should be made constantly.

Judging after the preliminary results, we believe that DST has enough magic to be of interest. In addition, it has a challenge: "Let me try" or "Maybe I succeed". Here the sequence "I hear and I forget, I see and I remember, I do and I understand". Playing with DST is a genuine 3Hs: hands-on, heads-on, hearts-on activity [12]. At last but not at least DST is a gender-neutral toy [13,14] and can help to improve practical skills [15]. We do believe that a popular use of DST will trigger new technical ideas and new benefits will be suggested by students and teachers. Once the principles are revealed, several improvements and optimizations can be done in terms of dimensions, materials used and this is an invitation for researchers, engineers, teachers and students.

References

1. Mitra S, Dangwal R (2010) Limits to self-organising systems of learning-the Kalikuppam experiment. British Journal of Educational Technology 41: 672-688.
2. Grosu I (2008) Driven Spinning Top.
3. Grosu I (2009) Driven Spinning Top.
4. Grosu I (2013) The Physics of the Driven Spinning Top, Proc. 10th International Conference HANDS-ON SCIENCE, Kosice/Slovakia, 1-5 July: 7-9.
5. Grosu I and Featonby D (2016) The driven spinning top. Physics Education 51: 033002.
6. Rekubus produces it under the name TOP SPEEDY.

7. Blalock CL, Lichenstein MJ, Owen S, Pruski L, Marshall C, et al. (2008) In pursuit of validity: A comprehensive review of science attitude instruments 1935-2005. International Journal of Science Education 30: 961-977.

8. Osborne J, Simon S, Collins S (2003) Attitude toward science: A review of the literature and its implications. International Journal of Science Education 25: 1049-1079.

9. Van Aalderen-Smeets, Van der Molen JH, Asma LJF (2012) Primary Teachers' Attitudes Toward Science: A New Theoretical Framework. Science Education 96: 158-182.

10. Vogt P, Kuhn J (2012) Analysing free fall with a smartphone acceleration sensor. The Physics Teacher 50: 182-183.

11. iStage_2_ Smartphones_ in_ Science _Teaching. pdf (2015)

12. Inan Z, Inan T (2015) 3Hs: hands-on, heahs-on & hearts-on early childhood science education. International Journal of Science Education 37: 1974-1991.

13. Francis B (2010) Gender, toys and learning. Oxford Review of Education 36: 325-344.

14. Grosu I (2013) Science: It's a Girl Thing Should Start with Adequate Toys. Open Journal of Education 1: 139-142.

15. Grosu I (2014) Improving Skills for School children. American Journal of Educational Research 2: 135-137.