Received : 11 January 2023
Revised : 5 April 2023
Accepted : 6 April 2023
Online : 12 April 2023
Published: 30 June 2023

DOI: doi.org/10.21009/1.09111

Newtonian Yoyo (*Lato-Lato*) Phenomenon in Indonesia: An Innovative Resource for IGCSE Physics Teaching and Learning?

Hamdi Akhsan[1,a)], Guruh Sukarno Putra[2,b)], Melly Ariska[1,c)]

[1]*Physics Education Department, Faculty of Teacher Training and Education, Universitas Sriwijaya, Indonesia*
[2]*Faculty of Education and Social Work, The University of Auckland, New Zealand*

✉: [a)]hamdiakhsan@fkip.unsri.ac.id, [b)]guruhsukarnoputragsp@gmail.com, [c)]mellyariska@fkip.unsri.ac.id

Abstract

This paper aims to stimulate a teaching and learning reflection for Indonesian IGCSE physics classrooms through a recent booming and recreational game of Newtonian yoyo called *lato-lato*. As physics is one of the critical and complex subjects in secondary school, it establishes a struggle for students to comprehend the concept of physics. The 21st-century physics education learning aims to promote high-end reasoning and deep understanding. Contextual physic learning will support this mission to reach maximum attainment for students. Physics through contextual knowledge will be more feasible for students. The recent phenomenon of *lato-lato* encounters a new interest for students. *Lato-lato* as a demonstrator and contextual example will be a resourceful material for several concepts of Newtonian mechanics, for instance: collision and energy. In addition, *lato-lato* may provide an advanced idea of circular motion, momentum, and impulse, oscillation. *Lato-lato* involvement may bring a chance for IGCSE curriculum adjustment in mechanics topics to become a significant pre-learning process. By using the adjusted curriculum, students are more likely to reach their maximum attainment and conceptual understanding of mechanics because students feel interested and encouraged to learn through a problem-solving and real-world setup. *Lato-lato* (Newtonian Yoyo) phenomenon may solve students' learning difficulties in IGCSE physics through a conceptual phenomenon.

Keywords: Newtonian yoyo (*lato-lato*), IGCSE Physics, learning resource

INTRODUCTION

This paper aims to stimulate a teaching and learning reflection in Indonesian physics classrooms through a recent booming and recreational game of Newtonian yoyo called *lato-lato*. This Newtonian yoyo brings many aspects of physics, precisely by its rules of playing. Many children in Indonesia see this *lato-lato* as a creative way to entertain themselves, so this notion accelerates the *lato-lato* phenomenon in society. Because of its popularity and identity as part of traditional games, *lato-lato* may solve science learning difficulties among children, particularly in physics. Besides, physics teachers should do any innovation to maintain meaningful learning. Thus, real-life experience makes students feel easier to learn physics concepts (Putranta et al. 2021).

As *lato-lato* will be a helpful resource for physics learning, educators must be concerned about student safety. Educators must explain the standard procedure of how to play *lato-lato* safely. The two pendulums might be separated if the rope doesn't look strong enough to retain the acting force. First,

educators and students must check whether the rope condition suits any classroom demonstration and challenge. If the rope is stringy, replace it immediately before playing. Due to its elasticity and centripetal forces, *lato-lato* will create a circular motion as students' hand moves upwards and downwards. Make sure that the students can maintain their constant hand movement. Reflecting to the fact, the Newtonian yoyo will produce uncomfortable noise in the environment, and this might lead to a new problem. So, it is preferable that during demonstration or challenge, students are separated into groups, and one group is given one *lato-lato* so it will not produce too much noise

Physics is one of the critical and complex subjects in secondary school. Physics considers the most difficult and challenging subject (Serhane et al. 2020). It establishes a need for students to comprehend the concept of physics (Sunal et al. 2016), particularly for students with mathematics problems (Gutulo & Tekello 2015). This notion supports that physics misconception in higher education is mostly throughout secondary education (Stylos et al. 2008). Only a small part of the student interested in physics (Mallari 2020). Besides, in some schools, apparatus to support physics learning is unavailable, making teachers have to innovate and look forward to other equipment to help their students (Gutolo & Tekello 2015). This perception indicates that innovative learning equipment is needed for the physics classroom. As 21st-century physics education learning aims to promote high-end reasoning and deep learning (Bao & Koenig 2019), contextual physic learning will support this mission to reach maximum student attainment. Physics through contextual learning will be more feasible for students. It is expected that contextual teaching and learning give the students maximum competence, and the learning process will be more natural with the involvement of daily life activities (Satriawan et al. 2020). Physics classrooms must be more fun with exciting games to motivate students (Kurniawan et al. 2017).

In physics, mechanics is the confrontation between students' ideas and reasoning of common sense and the theory taught (Serhane et al. 2020), and it is considered the most challenging topic in the physics syllabus in secondary school (Spatz et al. 2020). Without proper demonstration, students may experience a misconception and failure. Most of the physics materials in high school consist of mechanical-related theories. Misconception creates low confidence in students to succeed in the exam and learning objectives (Gjerde et al. 2021). Recent phenomenon of *lato-lato* encounter a new interest for children. This phenomenon could solve children's learning difficulties through a conceptual phenomenon. *Lato-lato* is a game that brings together two spherical pendulums; later, a rope connects the two pendulums. Then, the pendulum is banged and produces a "clack-clack-clack" sound. *Lato-lato* was popular in the 1960s and 1970s. The origin of *lato-lato* was made of glass, which was quite dangerous. However, today, *lato-lato* is made of polymer plastic, making it safer for children to play with it. The existence of *lato-lato* could improve teaching methods relevant to the physics concept (Panagou et al. 2021).

METHODS

The purpose of this paper is to stimulate a teaching and learning reflection for educational sectors as well as physics teachers. This paper uses descriptive qualitative research methodology, focusing on real problem and reflective of the everyday life of individuals, groups, societies and organizations (Punch & Oancea 2014). Using research question: is it possible for *lato-lato* to become an applicable resource for physics IGCSE learning? The stage of this research includes searching and identifiying relevant literatures (Li et al. 2022). This paper analyses literatures with particular physics context (conceptual physics and mechanics) and current IGCSE physics syllabus. Later, this paper analyses the content of each relevant literature, which implicitly relates to *lato-lato* term. The conclusion draws on physics contexts and contents to answer the research question. Ethical consideration is not applicable for this research. This study does not need any ethical consideration as it is categorized as low-risk (non-human research) and only analyzed literature and documents available publicly.

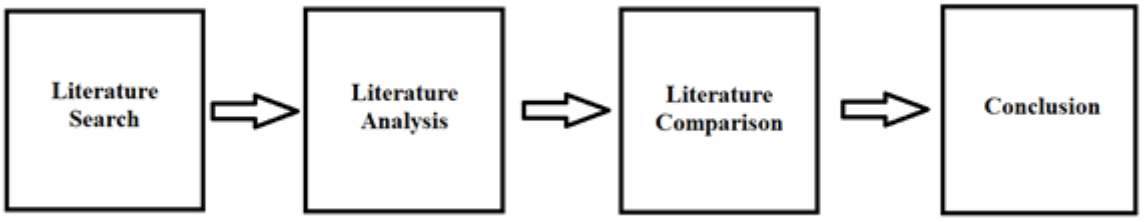


FIGURE 1. Research Methodology (Modification of Li et al. 2022)

RESULTS AND DISCUSSION

Lato-lato as a demonstrator and contextual example, will be a resourceful material for several concepts of Newtonian mechanics, for instance: collision and energy. In addition, *lato-lato* may provide an advanced concept of circular motion, momentum, and impulse, oscillation. There are several ways to play this Newtonian yoyo, given in the diagrams below.

Teachers can use all these three styles as a challenge for students. Through this challenge and problem-solving, playing a *lato-lato* gives a sense of enjoyment and meaningful learning to enhance students' critical thinking (Mallari 2020). Using contextual learning, students are capable of mastering deeper comprehension (Ramayani & Amalia 2022) of Newtonian mechanics. Moreover, the student will be more active in the classroom as teachers modify learning (Molla 2022), typically with the involvement of *lato-lato* in physics learning. In Physics IGCSE Syllabus, some points of learning outcomes can be used as a guide for teachers. The command words presented in the Physics IGCSE syllabus (CAIE 2020) may lead the teachers to look forward and modify teaching styles. The material and command words separate based on the styles of playing *lato-lato* mentioned previously, as shown in the TABLE 1.

TABLE 1. Playing styles of lato-lato

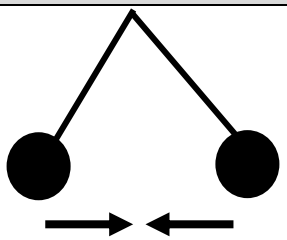
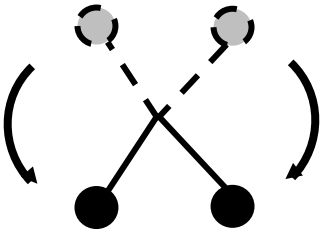
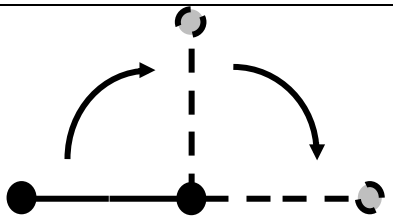
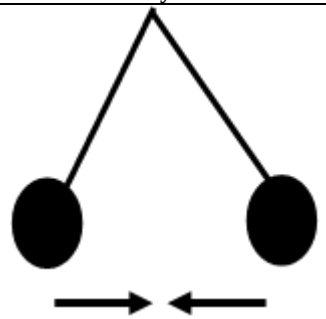
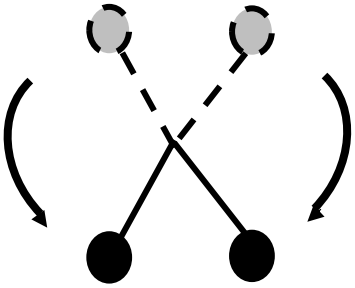
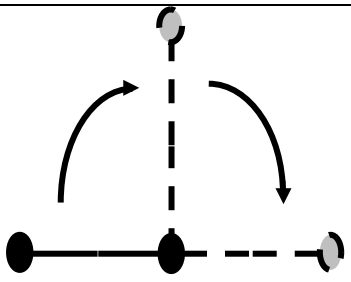
Style	Explanation
 Style 1	Two pendulums are banged in ordinary way.
 Style 2	Two pendulums are banged upwards and downwards, creating circular motion.
 Style 3	One pendulum is a center of rotation, while the other will rotate and knock the ground.

TABLE 2. IGCSE Physics Concept and Learning Objectives in Relation to *Lato-Lato* as a Learning Resource

Style	IGCSE Physics Concept and Learning Objectives
 	Concepts: Speed, Change of Energy, Momentum *Core learning objectives:* Students are able to demonstrate a deeper understanding about: • Basic kinematics: - Acceleration and deceleration - Changing speed : including gradient of v-t graph • Energy • Form of energy: - kinetic and gravitational energy, - chemical energy, - strain energy, - nuclear energy - internal energy • Energy transfer Conservation of energy *Additional learning objectives* Students are able to demonstrate a deeper understanding about: • Momentum and Impulse • Conservation of Momentum: including the principles Collision Possible command words*: apply, recognize, identify, explain* **Concept: Mass, Forces, Circular Motion, Centripetal Acceleration** *Core learning objectives:* Students are able to master the concept of • Mass of a body • Weight and gravitational force • Force • Force resultant *Additional learning objectives* Students are able to master the concept of • Inertia and moving body • Newton's Law • Perpendicular force Possible command words: *demonstrate, recall, describe, find, state, show*
	**Concepts: Inertia, equilibrium** *Core learning objectives:* Students are able to demonstrate a deeper understanding about: - Equilibrium : including rope tension - Center of mass Possible command words: *describe, find, explain, recognize*

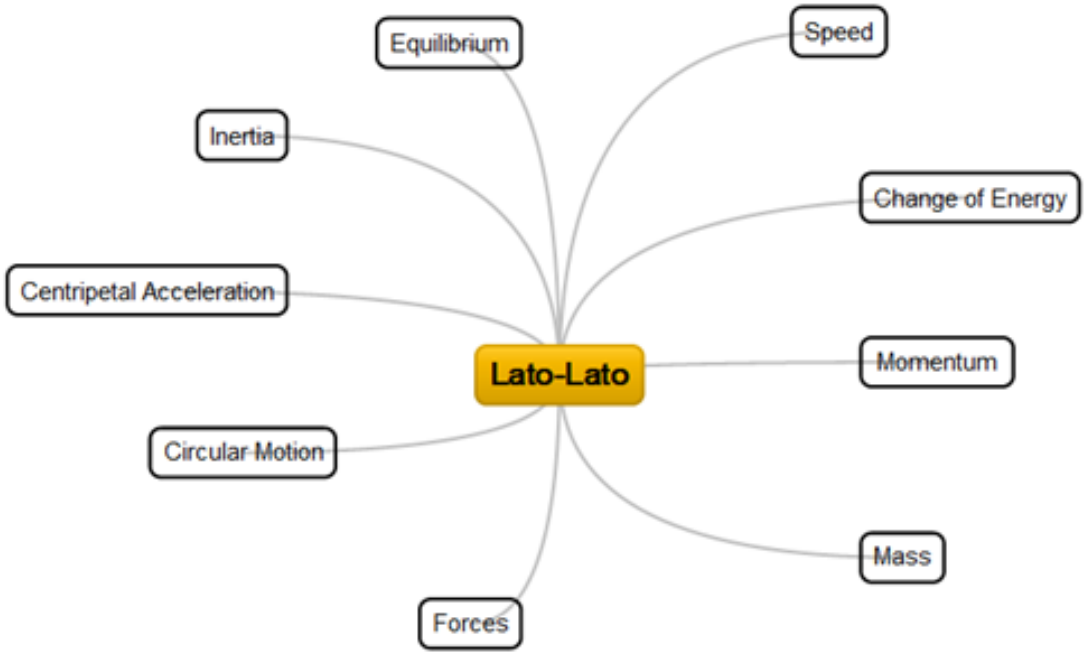


FIGURE 2. Physics concept intercorrelation to Lato-lato as a learning resource

In the perspective of TPACK (Koehler et al. 2014), *lato-lato* as a resourse will give a further integration to technology. In the classroom settings, educators may assign students to record their observation while playing *lato-lato*. With this integration, students will analyse the video through software (such as Tracker). This approach will lead to a higher conceptual understanding and critical thinking. As *lato-lato* will be a helpful resource for physics learning, educators must be concerned about student safety. Educators must explain the standard procedure of how to play *lato-lato* safely. The two pendulums might be separated if the rope doesn't look strong enough to retain the acting force. First, educators and students must check whether the rope condition suits any classroom demonstration and challenge. If the rope is stringy, replace it immediately before playing. Due to its elasticity and centripetal forces, *lato-lato* will create a circular motion as students' hand moves upwards and downwards. Make sure that the students can maintain their constant hand movement. Reflecting to the fact, the Newtonian yoyo will produce uncomfortable noise in the environment, and this might lead to a new problem. So, it is preferable that during demonstration or challenge, students are separated into groups. The sound of *lato-lato* is quite noisy. However, to reduce the noise, it is essential for educators to consider the use of this resource effectively, as manageable as possible.

CONCLUSION

Lato-lato was quite popular in late 2022. It went viral due to rapid sharing on social media. The educational sector and physics teachers must see this booming as an advantage, not otherwise. Typically, physics lesson is monotonous and theoretically explained, and rarely teachers intended to conduct a practical activity in the classroom (Gutolo & Tekello 2015). Furthermore, a physics classroom with student involvement in activities gives students a deeper understanding of the material (Napsawati & Kadir 2022). This perception brings an opportunity for *lato-lato* existence in the IGCSE physics classroom. Moreover, teachers must understand the basic concept of physics content before trying to show the students the relevant range of content and materials to support students' activity (Hernandez et al. 2014). *Lato-lato* involvement may allow IGCSE curriculum adjustment in mechanics topics to become a significant pre-learning process. By using an adjusted curriculum, students are more likely to reach their maximum attainment and conceptual understanding of mechanics (Spatz et al. 2020) because students feel interested and encouraged to learn through a problem-solving and real-

world setup (Mallari 2020). Thus, the challenges for teachers are curriculum adjustment, and material adaptation as students will face the confrontation between ideas, observation, and what teachers have taught (Serhane et al. 2020). Overall, *lato-lato* (Newtonian Yoyo) phenomenon may offer a solution for students' learning difficulties in IGCSE Physics through a conceptual phenomenon.

REFERENCES

Bao, L & Koenig, K 2019, 'Physics education research for 21st century learning', *Disciplinary and Interdisciplinary Science Education Research*, vol. 1, no. 1, pp. 1-12, https://doi.org/10.1186/s43031-019-0007-8.

CAIE 2020, 'Syllabus Cambridge IGCSE Physics 0625', Cambridge University Press, https://www.cambridgeinternational.org/programmes-and-qualifications/cambridge-igcse-physics-0625.

Gjerde, V, Holst, B & Kolstø, SD 2021, 'Integrating effective learning strategies in basic physics lectures: A thematic analysis', *Physical Review Physics Education Research*, vol. 17, no. 1, https://doi.org/10.1103/PhysRevPhysEducRes.17.010124.

Gutolo, SG & Tekello, KO 2015, 'Problems in the teaching and learning of physics at the secondary and preparatory schools, the cases wolaita and dwuro zones', *Global Journal of Human-Social Science*, Global Journals Inc. (USA), vol. 15, no. 7, pp. 1-5.

Hernandez, C, Ravn, O & Forero-Shelton, M 2014, 'Challenges in a Physics Course: Introducing Student-Centred Activities for Increased Learning', *In Journal of University Teaching & Learning Practice*, vol. 11, no. 2, p. 8, http://ro.uow.edu.au/jutlphttp://ro.uow.edu.au/jutlp/vol11/iss2/8.

Koehler, MJ, Mishra, P, Kereluik, K, Shin, TS & Graham, CR 2014, 'The technological pedagogical content knowledge framework', *In Handbook of Research on Educational Communications and Technology*, Springer New York, pp. 101-111, https://doi.org/10.1007/978-1-4614-3185-5_9.

Kurniawan, DT, Suhandi, A, Kaniawati, I & Rusdiana, D 2017, 'The Analysis of Learning Obstacle and Students Learning Motivation of Prospective Math Teachers in Basic Physics Class', *Journal of Physics: Conference Series*, vol. 812, no. 1, p. 012026, https://doi.org/10.1088/1742-6596/812/1/012026.

Li, Y, Wang, K, Xiao, Y & Wilson, SM 2022, 'Trends in Highly Cited Empirical Research in STEM Education: a Literature Review', *Journal for STEM Education Research*, vol. 5, no. 3, pp. 303-321, https://doi.org/10.1007/s41979-022-00081-7.

Mallari, RL 2020, 'Students' Attitudes and Approaches towards Physics Problem Solving: Basis for Intervention Program', *International Journal of Scientific and Research Publications (IJSRP)*, vol. 10, no. 11, pp. 241-247, https://doi.org/10.29322/ijsrp.10.11.2020.p10728.

Molla, MG 2022, 'Implementation of Physics Learning by Using the Guided Inquiry Method on the subject matter of Ohm's Law and Series-parallel Circuits, Effectiveness in terms of Learning Outcomes, Involvement and Constraints', *In International Journal of Basic and Applied Science*, vol. 11, no. 1, pp. 1-9, www.ijobas.pelnus.ac.id.

Napsawati & Kadir, F 2022, 'Analysis of Physics Practicum Problems Faced by Students during Distance Learning', *Jurnal Pendidikan Fisika*, vol. 10, no. 1, pp. 58-66, https://doi.org/10.26618/jpf.v10i1.5785.

Panagou, D, Kotsis, KT & Stylos, G 2021, 'An Empirical Study on the Evolution of Students' Perceptions in Basic Concepts of Physics of Primary and Secondary Education in Cyprus', *In Electronic Journal For Research In Science & Mathematics Education*, vol. 26, no. 2, pp. 91-109, https://ejrsme.icrsme.com/article/view/21441

Punch, K & Oancea, A 2014, 'Introduction to research methods in education (2nd ed.)', SAGE Publication.

Putranta, H, Kuswanto, H, Hajaroh, M, Dwiningrum, SIA & Rukiyati 2021, 'Strategies of physics learning based on traditional games in senior high schools during the Covid-19 pandemic', *Revista Mexicana de Fisica E*, vol. 19, no. 1, pp. 1-15, https://doi.org/10.31349/REVMEXFISE.19.010207.

Ramayani, N & Amalia, L 2022, 'The Analysis of Barriers to the Use of Physics Practicum Applications', *International Journal of Education and Teaching Zone*, vol. 1, no. 1, pp. 34-43, https://doi.org/10.57092/ijetz.v1i1.9.

Satriawan, M, Rosmiati, R, Widia, W, Sarnita, F, Suswati, L, Subhan, M & Fatimah, F 2020, 'Physics learning based contextual problems to enhance students' creative thinking skills in fluid topic', *Journal of Physics: Conference Series*, vol. 1521, no. 2, p. 022036, https://doi.org/10.1088/1742-6596/1521/2/022036.

Serhane, A, Debieche, M, Karima, B & Zeghdaoui, A 2020, 'Overcoming University Students' Alternative Conceptions in Newtonian Mechanics', *American Journal of Networks and Communications*, vol. 9, no. 2, 22-29, https://doi.org/10.11648/j.ajnc.20200902.12.

Spatz, V, Hopf, M, Wilhelm, T, Waltner, C & Wiesner, H 2020, 'Introduction to Newtonian mechanics via two-dimensional dynamics-The effects of a newly developed content structure on German middle school students', *In European Journal of Science and Mathematics Education*, vol. 8, no. 2, pp. 76-91, https://eric.ed.gov/?id=EJ1252766.

Stylos, G, Evangelakis, GA & Kotsis, KT 2008, 'Misconceptions on classical mechanics by freshman university students: A case study in a Physics Department in Greece', *Themes in Science and Technology Education*, Klidarithmos Computer Books, vol. 1, no. 2, pp. 157-177.

Sunal, DW, Dantzler, JA, Sunal, CS, Turner, DP, Harrell, JW, Simon, M & Aggarwal, MD 2016, 'The 21st Century Physics Classroom: What Students, Teachers, and Classroom Observers Report', *School Science and Mathematics*, vol. 116, no. 3, pp. 116-126.