JOURNAL OF INTERDISCIPLINARY PERSPECTIVES

ISSN Print: 2984-8288, ISSN Online: 2984-8385
Vol. 3 No. 3, pp. 45-49, March 2025

# Interactive Physics Toys in Teaching Basic Concepts of Linear Motion

**Manilyn R. Rosales*, Brando A. Piñero, Maria Chona Z. Futalan**
Foundation University, Dumaguete City, Negros Oriental, Philippines

*Corresponding Author Email: manilyn.rosales002@deped.gov.ph

**Date received**: December 9, 2024
**Date revised**: January 11, 2025
**Date accepted**: February 3, 2025

**Originality**: 88%
**Grammarly Score**: 99%
**Similarity**: 12%

**Recommended citation:**
Rosales, M., Piñero, B., Futalan, M.C. (2025). Interactive Physics toys in teaching basic concepts of linear motion. *Journal of Interdisciplinary Perspectives*, 3(3), 45-49. https://doi.org/10.69569/jip.2024.0666

**Abstract.** Grade 7 and 8 students did not receive adequate instruction on the fundamental concepts of linear motion due to the impact of the pandemic. This study aimed to examine the effectiveness of incorporating self-made interactive physics toys, such as a toy car with a string and beads, a balloon-powered toy car, and an acceleration toy car, in teaching the basic concepts of linear motion to 7th and 8th-grade students. The researcher employed a quasi-experimental design, specifically a one-group pretest-posttest design. Statistical tools such as percentage, mean, standard deviation, weighted mean, t-test for dependent data, and Spearman Rank-Order Correlation were used for data analysis. The study involved 21 students, divided into 7 groups with 3 members each. The results indicated a "fairly satisfactory" performance in the pretest and a "very satisfactory" performance in the posttest, with the difference in their performances being statistically significant. Additionally, the students demonstrated a "very high" level of interest in using the three self-made interactive physics toys. Moreover, this study suggests that incorporating self-made interactive toys significantly improves students' performance and interest in science. This heightened engagement results in better comprehension and retention of concepts and fosters a positive attitude toward science. Finally, a moderate and significant correlation was found between the student's interest in using the interactive toys and their post-test performance.

**Keywords:** Interest; Instructional approach; Physics; Self-made interactive Physics toys.

## 1.0 Introduction

Science education focuses on providing real-world experiences to drive scientific progress (Nida et al., 2021; Sæleset & Friedrichsen, 2021; Torres et al., 2021), and physics plays a crucial role in enhancing students' procedural skills and cognitive abilities (Daher et al., 2021; Krumphals & HaagenSchutzenhofer, 2021). However, recent studies indicate a decline in students' interest in physics at the secondary school level (O'Neill & Mcloughlin, 2021). Research by Steidtmann et al. (2023) also suggests a significant decrease in interest in physics from Grades 5 to 7, particularly from Grades 5 to 6. Multiple factors contribute to students' decreasing interest in physics, such as perceived teaching quality, lack of parental encouragement, insufficient motivation from physics teachers, the complexity of physics materials, and reduced career prospects for physics educators (Steidtmann et al., 2023).

In the Philippines, the MATATAG Curriculum is created based on diverse educational theories and models to enhance student involvement and improve learning results. By prioritizing fundamental skills and core competencies, the MATATAG Curriculum strives to establish a more compelling and efficient learning environment (Kilag et al., 2024). Nonetheless, Moro and Billote (2023) claimed that the Philippines is falling behind in physics education, as evidenced by recent national and international assessments. The latest PISA 2022 results, released on December 5, 2023, further confirmed this, indicating that Filipino students continue to perform poorly in math, reading, and science compared to their global counterparts (OECD, 2023).

After reviewing several studies, the researcher discovered that some studies focused only on evaluating physics students' conceptual understanding through traditional methods like lectures, diagrams, and videos. Moreover, there have been insufficient studies on self-made interactive toys as innovative teaching aids for learning the basic concept of linear motion. Thus, this study introduced a method for comprehending linear motion through self-made interactive physics toys to address these gaps. These toys include (a) a toy car with string and beads for distance and displacement, (b) a balloon-powered toy car for speed and velocity, and (c) an acceleration toy car for acceleration. Exploring these interactive physics toys, not commonly used in regular physics classes, can make learning physics more enjoyable and comprehensible.

The researcher conducted the study in a geographically isolated school with no available laboratory and equipment. The target school relies on its mother school, which, most of the time, cannot also provide the laboratory needs. With these in mind, the researcher recognized the significant need to investigate the significance of self-made interactive physics toys as a teaching aid for the basic concept of linear motion to assess students' interest levels and the impact of interactive physics toys on students' performance.

## 2.0 Methodology

### 2.1 Research Design

The researcher employed a quasi-experimental design, specifically a one-group pretest-posttest design. A quasi-experimental design is a research method used to evaluate the effects of an intervention without randomly assigning participants to experimental groups. It often involves preexisting groups and uses pretest and posttest measurements to compare outcomes before and after the intervention (Alvarez et al., 2022).

### 2.2 Research Locale

The study was conducted at Cangkue High School, where the researcher teaches, in Sitio Cangkue, Barangay Sto. Niño, Tanjay City, Negros Oriental.

### 2.3 Research Participants

The study's respondents were the 21 grade 7 and 8 students of Cangkue High School enrolled in the school year 2021-2022. They were divided into 7 groups with 3 members each. The 3 members per group had different roles to ensure that all of them manipulated the interactive physics toys.

### 2.4 Research Instrument

The researcher developed self-made toys using inexpensive and recyclable materials to help students understand basic concepts of linear motion, supported by an activity guide. The "Toy car with string and beads" demonstrated distance and displacement, the "Balloon-powered toy car" explained speed and velocity, and the "Acceleration toy car" illustrated acceleration. Activity guides provided instructions for using these toys, while pretest and posttest questionnaires assessed students' understanding before and after using them. Additionally, interest questionnaires, adapted from Piñero et al. (2023), measured students' interest in the toys. These instruments, including the activity guides and questionnaires, were validated by three science experts: a science supervisor, a Master Teacher, and a master's degree holder in Biological Science. A dry run was conducted to assess reliability using the test-retest method for test items and Cronbach’s alpha for interest questions, resulting in reliability values of 0.816 and 0.707, respectively, indicating strong reliability.

### 2.5 Data Gathering Procedure

The researcher prepared A letter of request, asking permission to conduct the study and distribute the questionnaires. This letter was signed by the Dean of the Foundation University- Graduate School and submitted to the Division Office for approval of the Division Superintendent. The approved request was then presented to the school head of another school, and the researcher conducted a dry run among thirty (30) Grade 7 students. The dry run allowed the researcher to test the self-made interactive physics toys. After the successful dry run, the researcher proceeded to experiment at Cangkue High School.

The study focused on teaching linear motion concepts, starting with theoretical discussions on distance and displacement (Day 1), speed and velocity (Day 2), and acceleration (Day 3). On Day 4, a pre-test was administered to assess students' initial understanding. Days 5, 6, and 7 involved hands-on activities using interactive toys, where students worked in groups of three to apply the concepts. A post-test on Days 8 and 9 evaluated the impact of the activities on their comprehension. On Day 10, students' interest and engagement with the interactive toys were assessed. Data from the tests and activities were then analyzed to interpret the study's outcome.

### 2.6 Ethical Considerations
The study was conducted by ethical research standards. Ethical approval was obtained from the Ethical Committee of the Foundation University Research Office. Participation by the respondents was entirely voluntary, with no pressure or coercion applied. To maintain confidentiality, students' personal information was kept private. Additionally, students who wished to withdraw from the study were given one month. After this period, their information remained confidential, and after one year, it was anonymized. Measures were taken to ensure the students were not exposed to harm or adverse effects during the study.

## 3.0 Results and Discussion
### 3.1 Difference in the Pretest and Posttest Performances of the Students
Table 1 on the next page shows the difference between students' pretest and posttest performances following an educational intervention involving self-made interactive physics toys. The pretest performance rating is 78.41%, while the posttest performance is 87.43%, indicating a 9.02 percentage point increase. A t-test for dependent data revealed that this increase was significant (p = 0.000).

**Table 1.** *Differences in the Pretest and Posttest Performances of the Students*

| Pretest (%) | Posttest (%) | D | T | p | Decision | Remark |
|---|---|---|---|---|---|---|
| 78.41 (Fairly Satisfactory) | 87.43 (Very Satisfactory) | 9.02 | 6.393 | 0.000 | Reject $H_{o1}$ | Significant |

These findings align with those of Ugwuanyi et al. (2019), who observed that students participating in practical physics activities achieved higher academic success than those who did not engage in hands-on experiences. Acabal et al. (2021) also demonstrated that using toys made from recyclable materials to teach fluid mechanics significantly enhances students' conceptual understanding, leading to improved performance. Similarly, Aghastya and Astuti (2019) found that interactive tools like car toys with video (TwV) significantly increased students' scores in kinematics concepts, indicating substantial educational benefits. These results suggest that the interactive toys positively impact students' understanding and retention of basic concepts of linear motion.

### 3.2 Students' Interest in Utilizing the Different Interactive Physics Toys
Table 2 reveals the students' interest levels in engaging in activities utilizing the different interactive physics toys. Based on the results, students' level of interest is "very high" in all of the self-made interactive physics toys with a composite $w\bar{x}$ of 4.53 (toy car with string and beads), 4.50 (balloon-powered toy car, and 4.46 (acceleration toy car). These values suggest that the lessons on the basic concepts of linear motion were made interesting through the self-made interactive physics toys and that students enjoyed, felt excited about their discoveries, and developed motivation to listen attentively to the teacher.

The result supports the findings of Gök and Sürmeli (2022) that middle school students' scientific creativity improved positively because of scientific toy design activities based on the engineering design process. Likewise, Acabal et al. (2021) asserted that the extent of students' interest in engaging themselves in activities using the localized toys for fluid mechanics is very high. Gainsan et al. (2021) also revealed the same, stating that students' interest in the localized linear motion track and localized projectile launcher is very high. They further found that when students utilized the linear motion track apparatus, they engaged more in classroom discussions. They went on to say that when localized toys were used, the students listened more attentively, and their abilities to answer questions were developed.

**Table 2.** *Level of Students' Interest in Utilizing the Different Interactive Physics Toys*

| Indicators | Toy Car with String and beads | | Balloon-Powered Toy Car | | Acceleration Toy Car | |
|---|---|---|---|---|---|---|
| | $w\bar{x}$ | VD | $w\bar{x}$ | VD | $w\bar{x}$ | VD |
| 1. The use of interactive physics toy cars in science discussions is interesting. | 4.76 | SA | 4.57 | SA | 4.67 | SA |
| 2. Using an interactive physics toy car helps me focus on the discussion of the concepts of distance and displacement, speed and velocity, and acceleration. | 4.48 | SA | 4.52 | SA | 4.29 | SA |
| 3. The basic concepts of linear motion fascinate me because of the use of interactive physics toy cars. | 4.57 | SA | 4.52 | SA | 4.24 | SA |
| 4. The use of interactive physics toy cars makes me curious about the nature of science, especially linear motion. | 4.38 | SA | 4.52 | SA | 4.62 | SA |
| 5. Using interactive physics toy cars makes me listen attentively to the teacher. | 4.57 | SA | 4.71 | SA | 4.57 | SA |
| 6. I enjoyed using the interactive physics toy cars. | 4.67 | SA | 4.43 | SA | 4.52 | SA |
| 7. The activity encouraged me to use my skills in manipulating objects. | 4.38 | SA | 4.19 | A | 4.19 | A |
| 8. The use of interactive physics toy cars makes me excited about what I'm going to find out, especially in the lesson about distance and displacement. | 4.76 | SA | 4.48 | SA | 4.57 | SA |
| 9. The activity made me realize that Physics is not merely a set of formulas that needs to be memorized. | 4.33 | SA | 4.48 | SA | 4.43 | SA |
| 10. It made me realize that with interactive physics toy cars, science concepts would be much more fun. | 4.38 | SA | 4.57 | SA | 4.48 | SA |
| **Composite** | **4.53** | **SA** | **4.50** | **SA** | **4.46** | **SA** |

### 3.3 Relationship between the Students' Interest Level and Their Posttest Performance

Table 3 shows how students' interest in using interactive toys correlates with their post-test performance. The results indicate a moderate and significant relationship (all p-values $< \alpha = 0.05$) between the use of the toy car with string and beads (rs = 0.433), balloon-powered toy car (rs = 0.486), and acceleration toy car (rs = 0.436) and their posttest performances.

**Table 3.** *Relationship between the Students' Interest Level and their Posttest Performance*

| Posttest Performance and Interest in Using: | $r_s$ | p-value | Decision | Remark |
|---|---|---|---|---|
| Toy Car with String and beads | 0.433 | 0.049 | Reject $H_{o2}$ | Significant |
| Balloon-Powered Toy Car | 0.486 | 0.026 | Reject $H_{o2}$ | Significant |
| Acceleration Toy Car | 0.436 | 0.048 | Reject $H_{o2}$ | Significant |

The results suggest that students who enjoyed using these toys tended to achieve higher post-test performances. This finding aligns with Scholastica (2020), which found that interest significantly drives higher achievement in physics. It supports the conventional interest theory that when students are interested in a subject, such as physics, they tend to focus on their studies, become actively engaged, and participate more. Similarly, the study by Li and Wong (2018) obtained statistically significant results, supporting the claim that experiments enhance students' academic performance.

## 4.0 Conclusions

The basic concept of linear motion is a physics concept closely related to students' daily lives. However, many students do not realize this and often ignore it. Understanding linear motion concepts can be challenging for students when taught through traditional methods such as lectures, diagrams, and videos. These concepts are often abstract, making it difficult for students to connect them to real-world experiences. Nonetheless, interactive physics toys, such as the toy car with string and beads, the balloon-powered toy car, and the acceleration toy car, provide a more practical and engaging way to learn. These educational tools allow students to directly observe and describe the motion of objects in terms of distance, displacement, speed, velocity, and acceleration. By physically interacting with these toys, students can transform abstract ideas into something tangible and easier to understand. This hands-on approach enhances their comprehension and makes learning more enjoyable and relevant. Moreover, this study suggests that incorporating self-made interactive toys significantly improves students' performance and interest in science. This heightened engagement results in better comprehension and retention of concepts and fosters a positive attitude toward science. Consequently, students are more inclined to pursue additional education and careers in scientific fields, ultimately contributing to a more scientifically literate society.

## 5.0 Contributions of Authors

The authors confirm their equal contribution to all aspects of this research. Ms. Rosales and Mr. Piñero conceptualized the research problem, while Dr. Futalan carried out the necessary protocols for conducting the study and handled the statistical analysis. All authors collaborated in discussing the findings, and they reviewed and approved the final version of this paper.

## 6.0 Funding

This research received no specific grant from any funding agency.

## 7.0 Conflict of Interests

All authors declared that they have no conflicts of interest as far as this study is concerned.

## 8.0 Acknowledgment

The authors thank the Department of Education and Foundation University for their assistance in conducting this study.

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