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A SCRABBLE-INSPIRED PHYSICS LEARNING TOOL TO ENHANCE UNDERSTANDING AND RETENTION OF NEWTON'S LAWS OF MOTION

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ABSTRACT

Despite the increasing use of digital tools and multimedia in classrooms, many students continue to struggle with understanding and remembering fundamental physics concepts, particularly Newton's Laws of Motion. These topics involve abstract ideas and scientific terms that are often difficult to grasp through traditional teaching methods. Recognizing these challenges, this innovation introduces a Scrabble-inspired physics learning tool designed to improve memory retention and conceptual understanding of Newton's Laws of Motion in an engaging and meaningful way. This interactive, word-based game promotes active recall and deeper learning through repeated exposure to physics terms and definitions. The tool is specifically developed for diploma-level physics students but is adaptable across various educational settings, including secondary school, matriculation, and pre-university programmes. In addition to improving conceptual retention, the tool also supports the development of 21st-century skills such as critical thinking and communication. It offers educators a creative and effective way to enhance physics instruction in the classroom. Ultimately, this tool helps students learn more effectively, understand concepts more clearly, and maintain lasting interest in physics.

Keywords: *Gamified Learning, Physics Education, Newton's Laws of Motion, Conceptual Understanding, Memory Retention.*

INTRODUCTION

In physics education, Newton's Laws of Motion are foundational concepts that students must grasp to understand motion and force. However, many diploma-level students struggle to retain definitions and apply these laws due to their abstract nature and technical terminology. Traditional lecture-based teaching often results in rote memorisation with limited conceptual understanding. Studies have shown that the complexity of science vocabulary significantly affects students' ability to comprehend and retain scientific concepts (Cervetti et al., 2015; Snow, 2010). Students become more engaged and better understand scientific terms when vocabulary is taught through interactive, meaningful, and game-based activities (Qian & Clark, 2016; Zainuddin et al., 2020). In addition, game-based learning has gained attention for its effectiveness in enhancing motivation and engagement, particularly in abstract science topics like physics (Zainuddin et al., 2020). To address these needs, we developed a Scrabble-inspired tool that combines active recall, collaborative play, and repeated exposure to key physics terms. This approach supports both conceptual mastery and the development of 21st-century skills such as communication and teamwork, offering an effective alternative to traditional instruction.

METHODS

This study used a quasi-experimental design to assess the effectiveness of integrating a word-based board game in physics instruction. The focus was on improving students' understanding and retention of Newton's Laws of Motion.

Game Design

This Scrabble-inspired board game was designed to be interactive, collaborative, and enjoyable while reinforcing Newtonian concepts. It includes questions, vocabulary application, and a scoring system to create a meaningful learning experience. The game targets three learning domains: cognitive (conceptual understanding), affective (interest and motivation), and behavioural (active terminology use and communication). The design aligns with Plass et al. (2015), who emphasized cognitive engagement in game-based learning.

Game Components

The game includes a board with scoring zones (Double Points, Bonus Zones), 100 letter tiles with point values, and a deck of Q&A cards. These cards test students on both definitions and applications of Newton's Laws. A scoring system allows manual recording or digital entry via QR code-linked Excel sheets. Table 1 illustrates the set of question prompts integrated into the Q&A cards, crafted to assess students' conceptual understanding.

Table 1.: Sample Questions from the Q&A Card Deck

No.	Question Prompt	Targeted Concept
1	A push or pull	Force
2	SI unit of force	Newton (N)
3	Law of action-reaction	Newton's Third Law
4	Law of inertia	Newton's First Law
5	The tendency of objects to resist a change in their state of motions	Inertia
6	An object will remain at ____ or in uniform motion in a straight line unless acted upon by a net external force	Newton's First Law
7	Force that opposes motion between two surfaces	Friction
8	The force of gravity acting on an object	Weight
9	Pointed perpendicular to the surface	Normal Force
10	The amount of matter in an object	Mass
11	The pull of one object on another object	Gravitational Force
12	Force equals mass times	Newton's Second Law

Game Setup and Rules

The game is played in pairs or small groups (two to four players or teams). Each team receives identical sets of tiles, and players take turns in a clockwise direction. Before starting, the board, tiles, cards, and score sheets are arranged to ensure a smooth session focused on learning. Words must be formed in straight lines (horizontally or vertically), and all plays must connect to existing tiles after the first turn. Incorrect spelling or isolated tiles result in no score. These rules ensure consistency and fairness.

Gameplay Procedure

Gameplay begins with a player drawing a Q&A card and reading the question aloud. The player must then answer the question verbally. If the answer is correct, the player is allowed to form the word or phrase corresponding to the answer using their letter tiles on the game board. The placement of tiles on the board should be strategic to take advantage of scoring multipliers such as Double Points zones. After placing the tiles, the player calculates their score based on the values of each letter used, along with any applicable bonus points. The score is then recorded either manually or through the linked digital system. The game continues with the next player drawing a new card and following the same steps. The game ends after a predetermined number of rounds or when all Q&A cards have been used. The player or team with the highest cumulative score is declared as the winner. A step-by-step infographic, as shown in Figure 1, visually demonstrates the game procedure from drawing question cards to placing letter tiles on the board.

Figure 1.:Step-by-step infographic demonstrating gameplay procedures

Educational Integration

This board game is deliberately designed to merge play with learning in a meaningful, student-centred context. As students participate in the game, they are exposed repeatedly to essential physics terms and concepts related to Newton's Laws. The process of answering questions, forming accurate scientific words, and discussing ideas with peers reinforces understanding through active recall and repetition. The collaborative and competitive elements of the game foster higher engagement, increase motivation, and support the development of soft skills such as teamwork and scientific communication. By shifting from passive to active learning, this innovation encourages deeper conceptual mastery while making the physics classroom more dynamic and enjoyable. These outcomes align with gamification research highlighting its effectiveness in promoting collaboration and meaningful student interaction (de Sousa Borgeset al., 2021).

RESULTS AND DISCUSSION

Initial classroom trials showed that the game improved students' understanding and retention of Newton's Laws. Students were more active, confident, and articulate in using physics terminology post-activity. Informal comparisons of student participation and verbal responses before and after the game indicated clearer use of terminology and better explanation of Newtonian concepts. Observations also revealed high levels of engagement and collaborative interaction among learners during gameplay.

Hamari et al. (2014) confirmed that gamification enhances motivation and learning behaviours, whereas Rutten et al. (2012) demonstrated the effectiveness of interactive tools in promoting conceptual understanding in science education. Wieman et al. (2010) also concluded that active learning strategies outperform traditional methods in improving student outcomes. While this study employed a quasi-experimental design without a control group, classroom-based evidence still supports the practical value of the tool in promoting active learning and concept retention.

CONCLUSION

This Scrabble-inspired learning tool has successfully enhanced student engagement and conceptual retention of Newton's Laws of Motion. By shifting instruction from passive memorisation to active, vocabulary-rich gameplay, students developed a stronger grasp of core physics concepts. Its flexible design makes it suitable for use at secondary, pre-university, and diploma levels. Future development could incorporate higher-order thinking tasks and real-world problem-solving to extend its educational impact. Given its proven effectiveness, the tool holds potential for commercialization as a ready-to-use classroom kit or digital resource.

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