Game-Based Learning to Engage Students With Physics and Astronomy Using a Board Game

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ABSTRACT

In this research article, the authors developed a novel astronomy board game and examined how this approach could facilitate the learning and teaching of astronomy topics covered in the new Irish Science Syllabus. A total of 119 post-primary students took part in the pilot trial across Ireland. Data was collected via feedback questionnaires, systematic observations and pre and post-test surveys. Results indicate that this astronomy board game significantly enhances students’ knowledge of astronomy concepts and perceptions of scientists. Furthermore, teachers showed positive attitudes towards this approach for teaching astronomy. Additionally, the game was demonstrated as a useful learning tool and as an activity to promote social skills. The findings offer a promising basis for further exploration of the integration of game-based approaches to physics education to promote active participation and interaction, balancing the learning objectives with play.

KEYWORDS
Astronomy, Board Game, Game-Based Learning, Physics Education, Serious Games

INTRODUCTION

Science literacy is globally acknowledged as essential for ensuring economic growth and social participation in modern society (Minister for Education, STEM Education Report, 2016). Several countries in Europe have stressed the need to provide an equal and more effective science teaching to encourage more students at all levels to pursue science degrees. In response, a number of recent studies have explored further the reasons why students choose science-related subjects at all levels, particularly physics. Although the study of physics is crucial to understanding the world around us and it is the basis of many other sciences, researchers have flagged diminishing interest in the subject at all levels compared to other science courses. In the Irish context, a comparison of different science subjects shows far fewer Irish post-primary students enrolling in physics than in chemistry or biology. To illustrate, between 1990 and 2010, the participation rate in the physics leaving certificate has decreased from 20% to 12% (Information retrieved from the State Examinations Commission, 2018). Additionally, there is a strong imbalance in the number of Irish teachers who hold a recognised qualification in physics at the junior cycle level. As a result, teachers who do not hold a degree/ background in physics are teaching this subject in post-primary school, i.e. out-of-field teachers
(Ingersoll, 2002). The majority of science teachers at the junior cycle level have a biology qualification which may also contribute to the dominance of biology as a subject choice for the Leaving Certificate (Minister for Education, STEM Education Report, 2016).

In response, recent years have seen a significant number of studies concerning the teaching and learning of physics in Ireland. As a result, a number of research-based teaching resources have been developed showing that approaches that actively engage students better influence students in constructing their knowledge and identity. These included problem-based learning approaches, collaborative learning (Chance & Bowe, 2015) and the use of video hooks in a physics classroom (McHugh & McCauley, 2016). However, in Ireland, secondary students view physics as a difficult subject with heavy conceptual mathematical workload and as a predominantly male subject (Politis, Killeavy, & Mitchell, 2007). Thus, in physics education, there is a need for materials that connect to learning outcomes as well as students’ previous experiences to create opportunities to engage learners with physics and improve the learning process.

The search for creative ways to enhance the teaching and learning of science subjects, combined with the growing popularity of games, has led to increased study of Game-Based Learning (GBL) in the classroom. The use of games in the classroom has steadily increased as researchers and educators alike become more convinced of their high potential to facilitate the learning of science subjects (Morris et al., 2013) and promote positive changes in the school curriculum (Barton et al., 2018; Smith & Munro, 2009). This methodology has also been shown to promote social development (Berland & Lee, 2012) and foster teamwork skills (Azizan et al., 2018).

Although the findings from previous studies suggest a promising future for games in education, embracing games for physics education is still a challenge for some teachers. In Ireland, science teachers seem to have limited access to teaching materials which engage students with astronomy and are aligned with the Irish Science Syllabus. Additionally, the lack of skills and familiarity with this methodology might constrain their capability and confidence to include a GBL approach in the school curriculum (Allsop & Jessel, 2015). Hence, there is an emerging need for studies focused on the development and implementation of physics games aligned with the syllabus to reinforce learning and engage students with physics, which is of particular importance for female students as recent studies have shown that girls are less likely to pursue a career in physics (Archer & DeWitt, 2015).

Here we present research findings on the use of a novel serious game, i.e. a game focused on teaching in addition to entertainment, as a resource capable of actively engaging students with physics and astronomy. This pilot study was conducted in secondary schools across Ireland and the UK to evaluate teacher and student perceptions, and acceptance of the learning process through game-based learning. The following questions were investigated:

- Does the use of GBL influence student learning of astronomy topics?
- What are student and teacher perceptions of learning through games?

**BACKGROUND**

**Physics Education**

Improvement of attainment in the subject of Physics has been a goal of government and industry in Ireland for a number of years, as scientific knowledge is essential for economic and social participation in an increasingly complex world (Institute of Physics, 2012). Over the last few years, there has been a significant change in the way physics is taught and experienced in the classroom, with the development of different approaches and new methodologies for teaching Physics (Dancy & Henderson, 2010). Thus, the introduction of student-centred teaching methodologies in the curriculum is key, since improving education is improving the community.
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