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Title	Game-based learning to engage students with physics and astronomy using a board game
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Publication Date	2019
Publication Information	Adriana, Cardinot, & Jessamyn A. Fairfield. (2019). Game-Based Learning to Engage Students With Physics and Astronomy Using a Board Game. International Journal of Game-Based Learning (IJGBL), 9(1), 42-57. doi: 10.4018/IJGBL.2019010104
Publisher	IGI Global
Link to publisher's version	https://dx.doi.org/10.4018/IJGBL.2019010104
Item record	http://hdl.handle.net/10379/14934
DOI	http://dx.doi.org/10.4018/IJGBL.2019010104

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

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ABSTRACT

In this research study, we 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 were collected via feedback questionnaires, systematic observations and pre and post-test surveys. Results indicate 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: Physics Education, Board Game, Game-Based Learning, Serious Games, Astronomy.

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

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 to 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.

Despite that, physics is often still presented and evaluated in a manner that focuses on idealised problem situations rather than real-life applications, restricting the usefulness of the knowledge acquired. Heuvelen (1991) reviewed many studies in physics education to find that traditional instruction fails to achieve the desired student objectives. As a result, there is a gap between the knowledge of physics built in the classroom and the reality experienced by the same students outside the classroom. According to Dewey (2013), instruction which focuses on the relationship between ideas helps students to see more possibilities and opportunities, improving their ability to judge and develop new practices. Therefore, a radical change is needed in the way physics education is carried out, and student feedback must be the motivating tool of that change (Wieman & Perkins, 2005; Heller & Hollabaugh, 1992). Crucially, physics instruction must include both theoretical and practical approaches, to connect the material to the daily lives of students, to avoid misconceptions and expand the diversity of careers related to physics.

To address this issue, across various studies, different methodologies that promote more meaningful learning of physics concepts have been investigated. Li & Tsai (2013) explored active-

learning rooted in constructivism, in which teachers are the enablers of learning and students are engaged in the process of learning. Meltzer & Manivannan (2002) have developed a “fully interactive physics lecture” and showed that students demonstrated a greater engagement during their class activities than in a traditional physics lecture. However, due to restraints of time and expertise, in many cases, the traditional lecture approach remains the method for teaching physics. The subject is still often treated superficially and not aligned with students’ career aspirations. However, several studies have identified that active learning might be a promising methodology to tackle these issues (Deslauriers, Schelew, & Wieman, 2011). Physics education needs more teaching resources that actively stimulate learners to ensure equality of opportunities for everyone in physics (McCullough, 2007). Changes in student profiles and classroom dynamics must lead to a change in how physics teachers can facilitate and optimise learning (Wieman & Perkins, 2005).

Game-Based Learning

The idea of implementing games for facilitating teaching is not a new concept as educators, researchers, policymakers and the popular press have been discussing games for learning in formal education since the 1960s (Scarfe, 1962). Game-based Learning (GBL) refers to the use of games to support teaching and learning (Wilson, Hailey, & Connolly, 2013). It is a student-centred approach which incorporates learning content into games (Gee, 2014), leading learners to develop and exercise a wide range of skills.

Knowledge construction that takes place when using games is fundamentally different from the learning experiences associated with traditional teaching tools (Vogrinc & Zuljan, 2010). The GBL methodology entails setting learning goals in which learners maintain the enjoyment of play while ensuring that students will absorb and embrace the knowledge (Skilbeck, 2017). Hence, students feel ownership over their learning and are motivated to establish relationships with other players. GBL has been shown to:

1. Present a challenge that motivates students to test their knowledge and skills (Garris, Ahlers, & Driskell, 2002);
2. Explore students’ abilities within the realm of play (Tschannen-Moran & Johnson, 2011);
3. Investigate roles and identities (Jarrett & Light, 2018);
4. Receive continuous and personalised feedback which gives students information about their progress (Azizan et al., 2018).

More recently, GBL has been explored in science education and prompted considerable attention in exploring how and why games might be powerful tools in the classroom (De Freitas, 2006). As a result of this interest, there is a significant body of literature available on game-based science learning that explores the potential benefits of GBL for knowledge construction and encouraging engagement with science subjects (Shaenfeld, 2016; Li & Tsai, 2013). In physics education, GBL has been shown as a valid methodology for teaching physics as it can incorporate realistic situations into gaming elements, such as competitiveness, challenges and motivation (Tuminaro & Redish, 2007).

Additionally, different frameworks have been previously explored for using both digital and non-digital games to promote physics learning. In Barab et al. (2007), the author investigates the use of game principles to obtain or increase science literacy of science subjects. Vogrinc & Zuljan (2010) examined the use of a board game to perform the cognitive process of problem-solving. Li & Tsai (2013) investigate the relationship between gamification and the affective side of science learning such as attitude, motivation, and interest. In Smith & Munro (2009) the potential of games to promote science learning for students was evaluated.

In the context of physics education, it is often argued that learning can be enhanced when students get a sense of what it is like to be real scientists. Gee (2014) stated that “games can show us how to get people to invest in new identities or roles, which can, in turn, become powerful motivators for new and deep learning in classrooms and workplaces”. This is particularly important in science to broaden students’ views of physics as there is a general concern over the low rate of

students, especially girls, choosing to study physics at the undergraduate level (Elsevier Report, Gender in the Global Research Landscape, 2017). Furthermore, incorporating game elements into physics lessons has many possible benefits for new learning experiences (Tuminaro & Redish, 2007). Driven by these considerations, in developing games for education, it is essential to have a careful balance between educational content and play (McClarty et al., 2012).

METHODOLOGY

Participants

The pilot study was conducted in seven post-primary schools located in Ireland and the UK with a total of 119 students (34% male, 66% female) who were attending science classes (See Table I), in both single-sex and mixed schools. The mean age of participants was 14.84 years (SD=1.06) with an age range of 12 to 17 years. A Mann-Whitney Test showed no significant relationship between age and gender ($Z = -0.579, p < 0.562$).

Table 1. Division of students according to class and gender.

Classes	Male	Female	Total
2nd year	33%	24%	27%
4th year	0%	27%	18%
5th year	35%	0%	12%
TY	15%	44%	34%
Other	17%	5%	9%

The study also included eight science teachers (5 male, 3 female) of which 75% have been teaching in secondary schools for more than six years.

Data collection

In this study, we used mixed methods research that blends quantitative and qualitative elements to collect data, analyse, interpret and contextualise findings. Data were collected via classroom observations, a feedback survey completed by teachers and students, pre and post-test for measuring knowledge construction with closed and open-ended questions, and a focus group with the students at the end of each session. All sessions of this pilot study were conducted by the same researcher to ensure consistency and avoid any possible influence on the results. This paper only presents data from the students who completed all stages of the evaluation.

The game

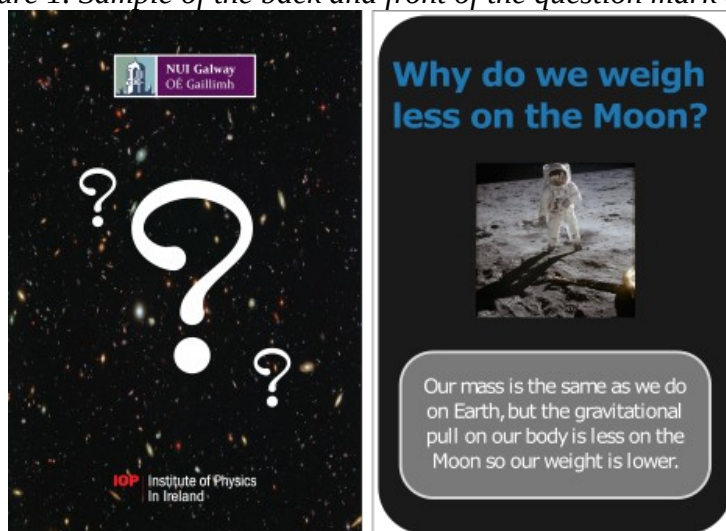
The proposed game is a dice-rolling game for four to six players designed to immerse and engage students with astronomy. For each turn, players roll the die and move forward on the game path a number of spaces determined by the number that appears on the die. The game has different types of spaces which direct players' actions. To decide the order of the players, each student rolls the die, and the player with the highest number goes first; players then take turns going clockwise around the table. As players advance around the board, they may land on spaces which require the players to draw a card with a question.

The cards of the game were designed targeting different levels of Bloom's Taxonomy which categorises learning into six levels of thinking, each adding new layers of complexity (Anderson et al., 2001). Each card requires the players to use different levels of cognitive skills such as recalling physics facts and comprehension of concepts previously learned in the classroom. All questions are aligned with the new Irish Science Syllabus for the Junior Cycle (2016). Card types are:

Question mark. This card has questions with level 1 (knowledge) and 2 (comprehension) of Bloom's Taxonomy. Cards have a question at the top, an image related to the question and the

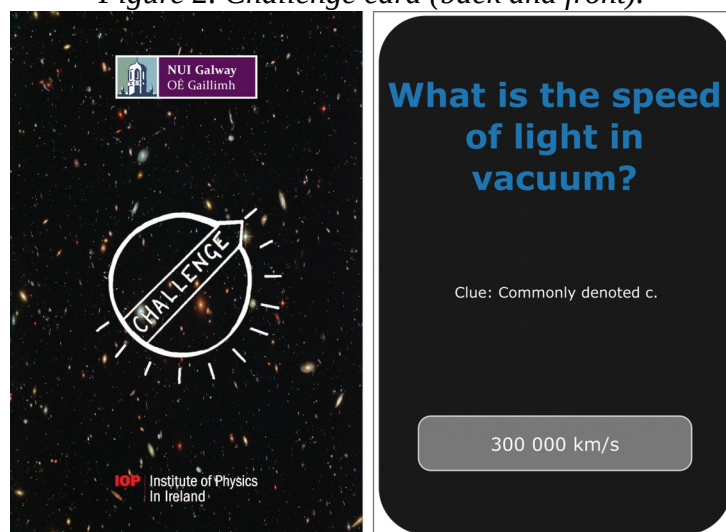
answer at the bottom in the grey box. When a player lands on a space with the question mark, one student in the group must take the card from the pile of cards and read out the question for the player on the move; the player then attempts to answer the question. If the players answer it correctly, he/she takes another turn. (See Fig. 1).

Figure 1. Sample of the back and front of the question mark card.



Challenge. The learning objective of this card involves levels 3 (application) and 5 (analyses) of Bloom's Taxonomy. This card includes a question, answer and a clue to help the player to answer the question (See Fig. 2). If the players answer it correctly, he/she takes another turn.

Figure 2. Challenge card (back and front).



Who am I? Besides promoting the learning of different astronomy facts in the school curriculum, we also aim to promote the diversity of the scientists who have contributed to the development of physics and astronomy. The 40 Who am I? cards show pictures of scientists (20 female and 20 male). Players were asked to guess the name of the person on the card, and there are three clues to help the player to answer. Each card has a number which players can consult on the list which contains the names and a short biography of the scientist's work. While it was not expected for players to know who all the people on the cards are, instead the Who am I? Cards were intended to spark curiosity and expand students' awareness of the diversity of scientists, which might affect their perception of physics and physicists (See Fig. 3).

Figure 3. Sample of the 'Who am I?' card (back and front). Clues for this card are: (1) British–American, (2) astronomer and astrophysicist and (3) known for explanation of the spectra of the Sun, more than 3,000,000 observations of variable stars.



The game board consisted of a path, and players move their token along this path with an uneven distribution of land-spaces. These included the *Question mark*, *Challenge*, *Who am I?*, and additional movements (go ahead, go back and take extra turns). Note that the mechanics of this game (rolling die) did not constrain students' knowledge construction as all land-spaces in the board pushed students to explain, think carefully about the physics concepts and to engage in active discussion with their peers. The board was also designed to have strong visual elements and graphics that would immerse students with astronomy.

Figure 4. The design of the board game



Procedure

Each intervention session lasted one hour and twenty minutes and the game time length was approximately forty-three minutes on average. In the beginning, students were introduced to the

researcher, informed of the general purpose of the pilot study, and given a description of the game and the evaluation process. Students were then divided randomly into five groups of four to six people each, depending on the number of students in the class, and were asked to take seats around the game board.

All students were given a number that was used as a reference to compare the pre and post-test. The anonymity of the students was preserved, and it is not possible to identify any participant. The teacher stayed in the classroom during the session and interacted with the students but did not help them to answer the questions.

A knowledge pre-test was administered with both open-ended and closed questions. This test aimed to measure the previous knowledge of astronomy topics that would be later discussed while playing the game. Once students finished answering the questions, the researcher explained the game rules and all groups started playing the game at the same time. The game ended once all players reached the finish point on the board. The time the first and the last player of each group took to hit the finish point was recorded. After the students finished playing the game, they were required to answer a post-test with the same questions of the initial knowledge test.

At the end of the session, the researcher conducted a focus group with all students to explore the students' point of view on the use of games in a science class. All interviews were recorded and transcribed at a later stage. In parallel with this assessment, both teachers and students were asked to fill out a feedback questionnaire at the very end of the session to evaluate the game. Thus, the data were collected with students answering on their own, without sharing or copying their answers in order to avoid any bias in the results.

RESULTS

The results presented here focus on the usefulness of the game for the teaching and learning of astronomy concepts that were recently included on the science Irish Syllabus. Therefore, no control group was used in this study.

A pairwise t-test was conducted to compare the answers choice in the astronomy knowledge test before and after playing the game. The result, $t(116)=-13.04$, $p<.001$, for the conceptual evaluation, indicated a significant difference in the number of correct answers, showing that students performed significantly better after playing the game.

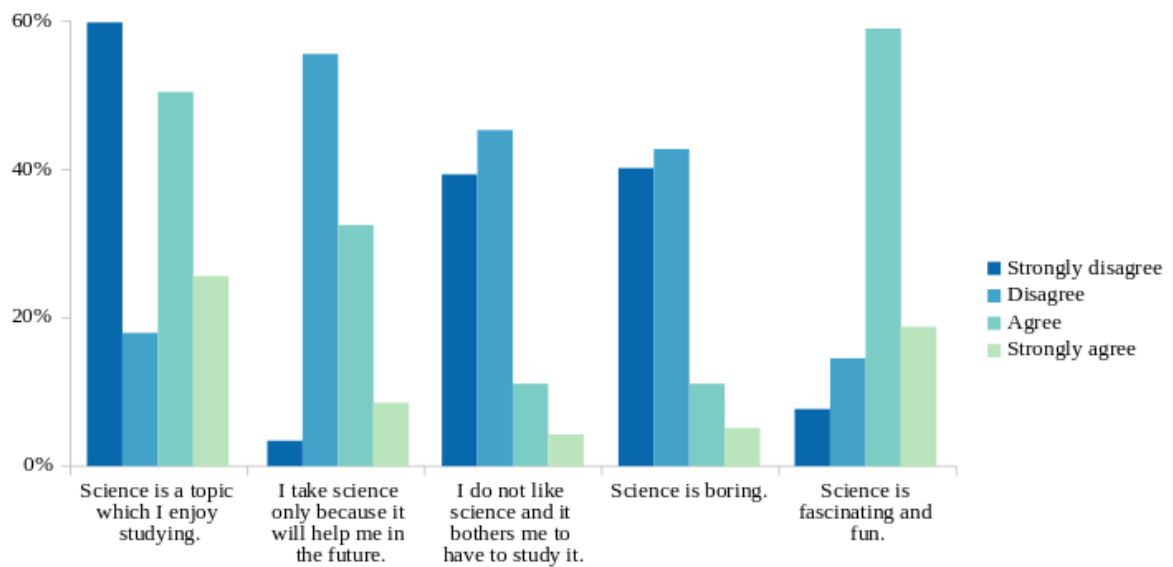
Table 2 – Paired t-test results of the astronomy knowledge before and after playing the game for all groups of students

	M	SD	t	df	Sig. (2-tailed)
Pre-test - Post-test	-1.79	1.49	-13.04	116	<.001

The actual difference in mean scores between groups was quite high. A one-way between groups analysis of variance (ANOVA) was conducted to explore whether students' gender influenced the knowledge test scores. There was no statistically significant difference at the $p<0.621$ level in mean scores in the pre-test and post knowledge test between female and male students.

The majority of the students (73.5%) stated that their physics/science classes are challenging, but they can understand. Although 76% of students answered that they enjoy studying science and 77.8% of students hold positive views of science, 59% of those student shave different motivations for studying other than the application of science in their future career.

Figure 5 – Students opinion on science (N=117).



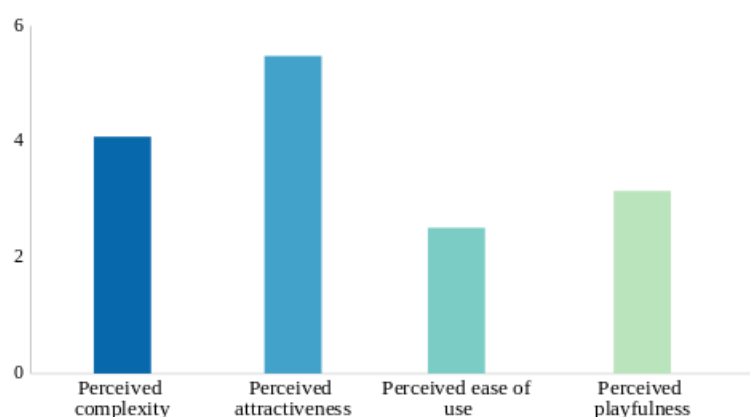
In terms of the use of the perceived usefulness of the game, both teachers and students had positive perceptions toward the game. As shown in Table 3, over 80% of the students were deeply engaged in discussing the topics with their peers and enjoyed playing an astronomy game. However, only 38.8% stated that they could fully understand what was being asked in the cards.

Table 3 – Students evaluation of different aspects of the game (N=117).

	Yes	No	Not sure
The topics discussed were interesting	80.2%	7.7%	12.1%
The questions were easy to understand	38.8%	42.2%	18.9%
I enjoyed discussing this topic with my classmates	75%	11.2%	13.8%
We were given enough time for discussion	83.6%	8.6%	6.9%
The facilitators encouraged participation	85.3%	2.6%	12.1%
I got a chance to have my say	94%	2.6%	3.4%
I felt that I was listened to	90.5%	2.6%	6.9%

A six-point rating scale was employed to measure the level of ease of use of the game, the playing time, attractiveness and ease of use of the supporting materials (instructions and rules). Perceived complexity received an average score ($M=4.09$, standard deviation $[SD]=1.18$), playing time was classified as just right ($M=3.46$, $SD=0.94$), attractiveness scores indicated that they highly liked the game design ($M=5.16$, $SD=1.03$), and satisfaction level with the written material showed that the game was straightforward and easy to follow ($M = 2.27$, $SD=1.43$).

Figure 6 – Students' evaluation of different aspects of the game (N=112).



Students displayed a high level of satisfaction with the learning experience by playing the game. The following quotes from the focus group conducted with the students at the end of the session illustrate their perceptions of the game and learning astronomy.

"It's a very interesting game and we all worked together."

"Even though it's a science game, there was a lot of fun and there lots of learn."

"I liked the questions a lot because I thought they are quite interesting and also the who am I? card, I basically had no idea who they were so I learned something new about these people and their work."

"I liked how it gave us the clues in the challenge."

"The layout and questions are very interesting"

"I liked that we were having fun while studying."

In addition to evaluating the game from the students' perspectives, we also investigated the teachers' perspectives of the game. The first part of the questionnaire focused on the demographic questions (age, gender, teaching experience) and the approaches used by the teachers during their classes. In general, the majority of teachers (90%) mentioned that cooperation between students is the best way to promote learning in the classroom. Along with that, discussion (100%), problem-solving (100%), demonstration (100%) and laboratory (100%) were highlighted as approaches used in their classroom. The second part of the questionnaire was focused on the game and its applicability for the teaching of physics. Teachers rated of different aspects of the game, with one being the lowest and ten highest score for each aspect (see Table 4).

Table 4 – Teachers' evaluation of different aspects of the game (N=9).

	Mean	SD	Min	Max
Difficult of the questions	7.00	2.27	4	9
Perceived ease of use	9.38	0.52	9	10
Perceived playfulness	9.00	1.07	7	10
Usability of the game for teaching physics	9.13	0.99	8	10
Overall style of the game	8.63	1.30	6	10
Instructions enclosed in the game	8.50	0.93	7	10
Stimulating discussion	7.75	1.83	5	10
Recommend this game to other science teachers	9.5	0.76	8	10

Teachers were also asked to describe how they could use the game during their classes. Among the suggestions, teachers mentioned that they could use the game as a revision tool in the run-up to an exam, to reinforce learning, as an introduction to different physics concepts and to adapt for another science subject (mix astronomy and chemistry/biology topics). Figure 7 also shows five potential educational applications of the game in their classroom on a five-point Likert scale (1=poor, 2=fair, 3=good, 4=very good and 5=excellent). Furthermore, the last question of the teacher questionnaire required the teachers to explain how they would describe the game to their colleagues. The following quotes were extracted from the teachers' questionnaires.

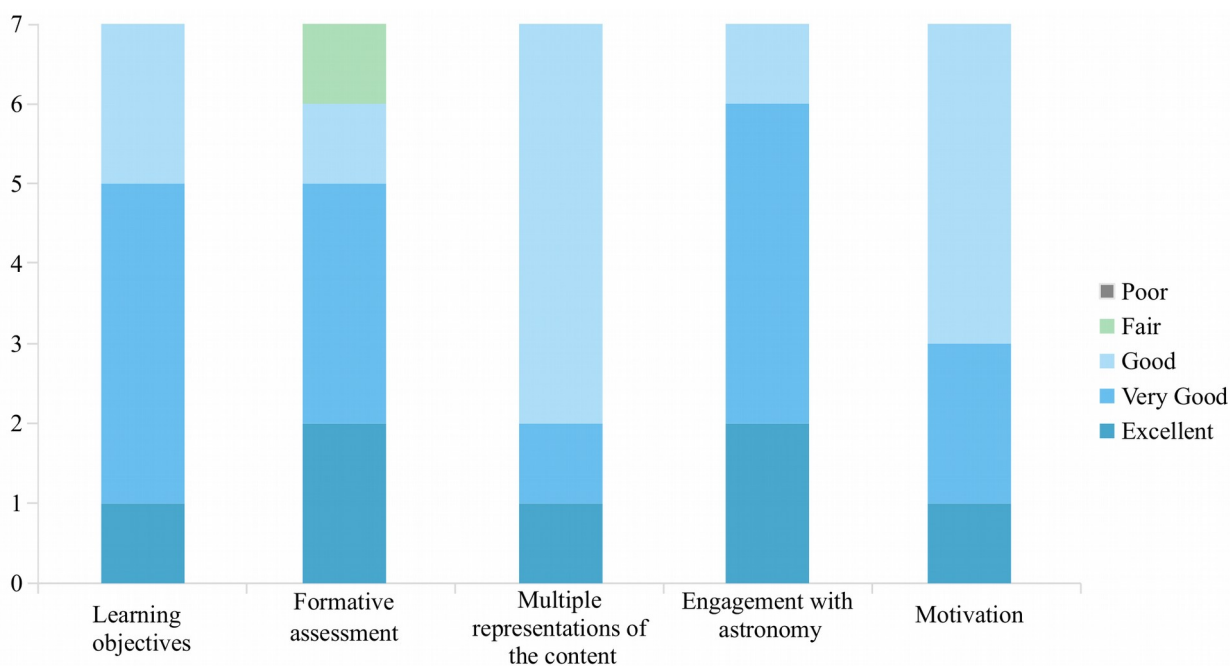
"It will engage pupils quickly, encourage discussion, and lead to valuable group learning."

"It is a game that engages kids and gets them thinking about astronomy."

"Great fun way to reinforce hard to understand topics"

"This game will encourage group work/ peer learning. Your students will really enjoy this game and will still be learning something. This game is very adaptable."

Figure 7 – Game applicability for the teaching of astronomy (N=8).



DISCUSSION

In our pilot study, the results align with previous studies suggesting that Game-Based Learning can increase student engagement with science and promote science literacy. Overall, students showed a highly positive attitude towards the learning of astronomy through the game. The knowledge test indicated that this game has the potential to affect students' knowledge of astronomy concepts. The students' perception was that the game made the learning of astronomy topics more enjoyable and interactive as they could learn physics through playing. According to Angell et al. (2004), students see physics as a difficult subject, as it is presented in a very abstract way with a heavy workload. Thereby, it is crucial to enable active learning of physics and students should be given opportunities to participate more fully in the learning process by exploring physics from different points of view.

In 2016, the Irish Junior Cycle Syllabus was revised and the new programme included the introduction of Earth and Space contents for post-primary students. This change required teachers to understand not only the astronomy topics but also how they should be delivered during the physics lessons. In this game, we aimed to develop a teaching resource aligned with the science curriculum that would sustain student interest in physics and promote science skills. The results revealed that

the students performed equally well regardless of their age and perceived the game as easy to follow, useful for reinforcing learning, visually appealing, playful and very interactive. Although only 40% of students found questions easy to understand, the questions in the cards are aligned with the Bloom's taxonomy which regularly required students to take in new information and tested what they already knew in different levels (remember, understand, apply, analyse). This ensured that students were given the opportunity to learn while progressing in the game and made it possible to achieve the learning goals of the game. In addition, teachers found that the game allowed their students to be more involved in and engaged with physics. They also reported that the game could be incorporated into the school curricula because it enables students to understand physics concepts as well as empower them by giving a sense of ownership of their learning.

Physics has an image problem. According to DeWitt, Archer, & Moote (2018), students' identity in relation to physics is shaped by their experience in the classroom and their future career plans. Thereby, it is important to create an environment that not only encourages the learning of physics but also broaden students' views of physics and its applications. To tackle this issue, in this game, we designed the card 'Who am I?' in which students became familiar with a wide range of both female and male physicists and astronomers, and what type of work they have done. Although this was a short intervention, student awareness of female scientists increased after playing the game which may affect how the participants of this pilot study perceive physics.

Furthermore, the usability of the game was also evaluated. This is an important aspect to be explored for any educational resource to increase its application in classrooms. Teachers mentioned different ways in which the game could be used, as it has very simple mechanics and is easily adaptable to include other content from the curriculum. Thus, all students were able to play the game regardless of their previous experience with non-digital games or prior knowledge of astronomy concepts.

Based on participants' responses, the authors were highly encouraged to further and expand this pilot research accordingly. As shown in the results section, students and teachers alike have shown great interest to use the proposed game in their learning. The proposed game is still under development, therefore there are aspects of the game design that needs further improvements. For example, the inclusion of questions that requires a higher level of problem thinking and refinement of the game mechanics would both promote more interaction among players. Our future works will be strengthening game design, mechanics, features that promote interactions, and an in-depth review of the game narrative.

Lastly, we acknowledge some limitations of this study. First, long-term effect cannot be guaranteed as there was no evaluation of retention after the intervention. This pilot study was focused on investigating the perceived usefulness of the game by both teachers and students. Hence no post retention test was conducted. We suggest that long-term effect should be investigated in future work. Second, students' answer might have some bias due to the novelty effect, i.e. the improvement in the score of correct questions in the post-test may have occurred due to exposure to a new resource and not to the learning gained while playing. In future work, students' previous experience with games in their physics/science classes should be measured before the game session to ensure that any effect observed is only due to the interaction with the game. Also, teachers and students suggested changes in the level of questions for early year students (first years of the junior cycle) as overly challenging questions did not engage younger students in a discussion.

CONCLUSION

In this paper, we presented a description of a pilot study aimed at investigating the use and initial design of a board game for the teaching and learning of astronomy topics from the Irish Science Syllabus. The results presented from the pre- and post-test survey shows that knowledge significantly increased after playing the game. We also identified that a Game-Based Learning (GBL) resource could motivate and engage students with physics while enhancing the astronomy knowledge. In this pilot study, there was no statistical difference in the results among girls and boys suggesting that gender does not affect the learning experience through games. The results of this

study offer several implications for researchers, teachers and designers alike. First, the game has very simple rules and an easy to follow mechanics which makes the game playable for everyone regardless of their age or previous knowledge of astronomy. Second, competition among students promoted learning, and further investigation concerning self-efficacy beliefs or behavioural learning patterns would be of interest. Note that, when developing and using GBL resources for physics education, it is essential to understand what motivates learners and integrate this into the game learning objectives. Third, it provides opportunities to change the way physics is experienced in schools. This makes student engagement and participation in physics more diversity and unbiased by presenting physics in different contexts.

GBL is an active learning methodology that provides students with immersive experiences. It gives them a sense of real-world situations for more in-depth learning, providing an opportunity to broaden their views of science. Effective physics teaching must go beyond using formulae and memorising terms so that students are encouraged to participate in physics class actively and further discuss what they are thinking and doing. Thus, GBL offers a student-centred approach for physics education due to its flexibility to fit different learning objectives and skill development, albeit an approach that may require more time and effort from the teacher. Thereby, this work has shown how a simple board game can be used for increasing student awareness of physics, tackling student misconceptions and reducing content abstractness with content that is aligned with the curriculum without requiring extra workload from the teacher.

ACKNOWLEDGEMENTS

This work was supported by CAPES-Brazil scholarship number {88881.128466/2016-01}. We would like to thank the Institute of Physics in Ireland for their support. A special thanks to all students and teachers who participated in this research.

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