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Title	Entertaining physics education: using an astronomy board game to enhance student learning and motivation
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Publication Date	2018-07-09
Publication Information	Cardinot, Adriana, & Fairfield, Jessamyn A. (2018). Entertaining physics education: using an astronomy board game to enhance student learning and motivation. Paper presented at the GIREP-MPTL 2018 Research and Innovation in Physics education: two sides of the same coin, San Sebastian, Spain, 09-13 July.
Publisher	GIREP-MPTL 2018
Link to publisher's version	https://www.girep2018.com/contenidos/files/abstracts/resumen/autor/199_abs_con_v1.pdf
Item record	http://hdl.handle.net/10379/14936

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Entertaining Physics Education: Using an Astronomy Board Game to Enhance Student Learning and Motivation

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Abstract. This study examines the effects of a novel Astronomy Board Game on students' science performance, their attitudes towards learning Science through games and their perception of scientists. Post-primary students in Ireland and the UK of various ages (n=119) took part in the pilot trial. Data were collected via pre- and post-test, feedback questionnaire and focus groups. The results indicated significant improvements in student's learning of astronomy topics, suggesting the inclusion of games in the classroom affects student learning and perception of scientists.

1 Introduction

Educational games have the potential to stimulate learning, to increase engagement with different subjects and develop other skills such as creative and critical thinking [1]. Despite large number of studies supporting that using GBL approach is a good strategy for teaching complex subjects in science [2-4], there is still lack of educational GBL materials to support teaching and learning of Physics concepts.

In Ireland, the recent inclusion of Earth and Space Science (ESS) topics in the new Junior Certificate Science Curriculum highlights the need for novel initiatives to support ESS education and provide opportunities for making connections between Physics, other subjects, and their daily life [5]. However, there is a lack of material to deeply engage students in the learning process which is also aligned with the school curriculum. This study aims to investigate the use of a novel non-digital game for the teaching and learning of Astronomy and Physics concepts, examining students' acceptance of games in the classroom and their attitudes towards scientists.

2 Methodology

In this research, we used a mixed method approach (qualitative and quantitative) for data collection and analysis. Data was collected via pre and post-test for measuring knowledge construction with closed and open-ended questions, a feedback questionnaire and a focus group at the end of the gameplay session. Each school visit took 1 hour and 20 minutes and the average gameplay length was approximately 42.5 minutes (SD=0.009). All groups were instructed by the same researcher to avoid any possible bias on the results.

2.1 Participants

Participants were 119 post-primary students (33.6% male, 66.4% female), ranging in age from 12 to 17 years old (M=14.84 years, SD= 1.06) and 9 physics teachers (66.7% male, 33.3% female). All students included in the research were attending a science subject in different classes (see Table 1) and were based in different counties in Ireland and in the UK.

Table 1. Division of students according to class and gender (f: number of students).

Classes	Male		Female		Total	
	f	%	f	%	f	%
2 nd year	13	32.5%	19	24.1%	32	26.9%
4 th year	0	0.0%	21	26.6%	21	17.6%
5 th year	14	35.0%	0	0.0%	14	11.8%
TY	6	15.0%	35	44.3%	41	34.5%
Other	7	17.5%	4	5.1%	11	9.2%

2.2 Game Design

The astronomy board game was developed using Design-Based Research Methodology (DBR) [6]. The research process of this study was divided into three stages: preparation of the research tools, experimental (game validation in schools) and data analysis. The learning mechanism in the board game focused on integrating student-centred pedagogical elements into the design process which made gameplay more enjoyable.

To enable teachers to use our educational games during class, our board game is aligned with the educational objectives contained in the new Irish Science Syllabus. The game consists of a board, three types of cards with different level of questions about the Solar System and scientists, a six-sided die, and instructions for playing the game.

3 Results

Preliminary results showed that students and teachers responded positively to our proposed game, felt that the activity facilitated learning, and would recommend it to others. A paired t-test was performed to examine whether students' performance improvements after playing the game. The results indicated that the post-test scores are significantly higher than the average pre-test score. Also, the t-test indicated a notable difference in the students' perception of female scientists ($t(118)=10.7$, $p<0.001$), indicating that the game also had a positive impact on promoting female scientists.

4 Discussion and Conclusion

This study aimed to determine if the astronomy educational game could assist post-primary students in the acquisition of astronomy knowledge, investigate students' reactions to of our educational game and their attitudes towards scientists. Students and teachers showed positive attitudes in playing the game and highly accepted its inclusion as a teaching method in the classroom. Participants also felt that the educational game contributed to enhance motivation and engagement with Physics and to improve their learning performance in Astronomy. Future research will continue to examine the use of non-digital games for the inclusion and promotion of complex subjects in Physics and how collaborative interaction among players could generate learning gains.

Acknowledgements

This research is supported by the Coordination of Improvement of Higher Education Personnel (CAPES-Brazil) grant number DOC_PLENO - 88881.128466/2016-01. Development of the game was funded by the Institute of Physics, Ireland.

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