

# GAME-BASED LEARNING AND ASTRONOMY

## AN INVESTIGATION OF CONCEPTUAL KNOWLEDGE AND AFFECTIVE LEARNING

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### 1

## BACKGROUND

- Game-Based Learning (GBL) has emerged as a potential resource to enhance students' cognitive and affective learning in the context of astronomy education [1].
- However, the inclusion of games in astronomy education has been hampered by the lack of validated astronomy games aligned with the science curriculum.
- In this study, astronomy non-digital games were investigated for their potential to enhance secondary students' conceptual knowledge, motivation and attitudes towards astronomy.

### 2

## THE DEVELOPMENT JOURNEY

- Game development involved three iterative cycles with teachers and students to refine the content that would be embedded in the games and to adapt game mechanics and design to develop intrinsically motivating games.
- Four board games were developed based on popular games mechanics such as dice rolling, puzzles and cooperative games.



### 3

## MAPPING THE SIGNIFICANCE

### IRISH SCIENCE SYLLABUS



Astronomy was only included in the formal syllabus in 2015.

Recently, the Irish science curriculum at Junior Cycle level was reformed towards a skills based syllabus. Also, a new strand called Earth & Space was created to include astronomy in formal education.

### OUT-OF-FIELD TEACHERS



Majority of JC science teachers have a degree in Biology.

More than half of the Irish JC science teachers are qualified in Biology while "fewer than one fifth are qualified in Physics" [2]. There are very few astronomy continuing professional development opportunities available.

### TEACHING RESOURCES



There is a lack of resources for teaching astronomy.

At present, there are a limited number of teaching resources aligned with the new science curriculum [3] available for science teachers. The Junior Cycle official body only provides three lesson plans to support teachers.

### IMPORTANCE OF ASTRONOMY



Astronomy has many links to other disciplines in science.

Astronomy has many connections to other STEM disciplines, such as biology, chemistry, physics, geology. Thus, astronomy could be used to attract young people to science and technology as fields of study or potential careers.

### 4

## RESEARCH DESIGN

This study employed a nonequivalent quasi-experimental design using a mixed-methods approach to collect data from Irish students aged between 11 to 16 years (Junior Cycle level). The experiment involved a 6-weeks instruction (~1h per week), in which each teaching session astronomy involved a different game.



498 Secondary students enrolled at Junior cycle level: 55% Female, 33% Male, 1.1% Prefer not to say.



10 Schools located in Ireland participated in the study, involving all years of JC: 1<sup>st</sup> Year (37%), 2<sup>nd</sup> Year (33%) and 3<sup>rd</sup> Year (30%).



Data collection instruments included a knowledge diagnostic test, motivation questionnaire and group interviews.

# PRELIMINARY FINDINGS

## Conceptual Knowledge

67%

increase of students' knowledge gain in treatment group between pre- to post-test design.

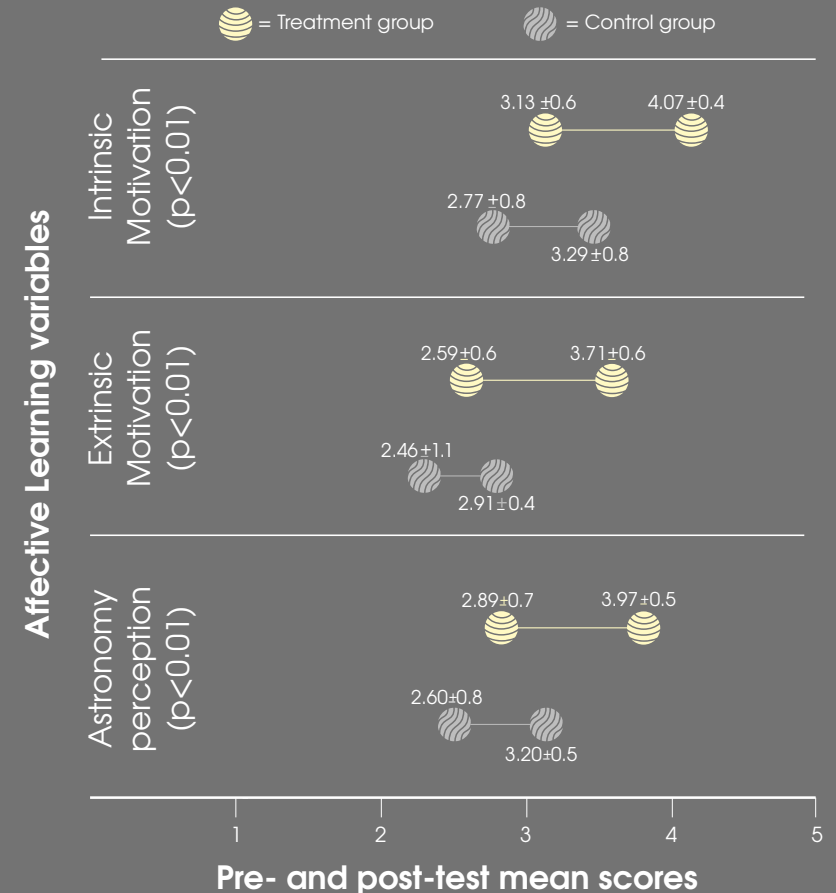
- Reduction in the number of alternative ideas about seasons, gravity and the Big Bang.
- Although all groups showed an increase in their post-test means, 2<sup>nd</sup> Year group showed greater and more statistically significant learning gains.
- Collaboration among players, game challenges and communication mediums of the GBL instruction were the aspects that most affected students' learning.

## Affective Domain

72%

of the students who participated in the GBL, lessons were more likely to report higher intrinsic motivation to learn and a more positive perception of astronomy.

- Learning through play significantly enhances students' perceptions of astronomy and scientists.
- GBL instruction supported students to improve their attitudinal constructs towards astronomy such as self-efficacy and perceived value of astronomy.
- Non-digital games could increase both extrinsic and intrinsic motivation, positively affecting student engagement with astronomy.



Participants' pre and post mean for each some of the motivation components. We observed an increase in all cases, but the magnitude of the increase was greater and statistically significant only for the treatment group.

## 6

## FUTURE WORK

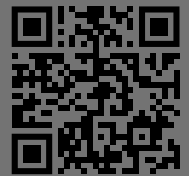
- Further investigate the aspects of GBL that promote/constrain conceptual knowledge change and affective learning.
- Analyse flexibility in student reasoning and discourse differences between pre- and post-instruction.
- Explore how the game components impact students motivation to learn attitudes towards astronomy.

## 7

## REFERENCES

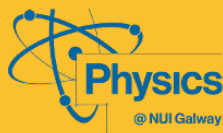
- [1] Cardinot & Fairfield, 2019. International Journal of Game-Based Learning.
- [2] STEM Education in the Irish School System, 2016. Department of Education and Skills.
- [3] Junior Cycle for Teachers Support Service. Visited in September 2020.

Want a copy of the games? Just fill out the form.



[bit.ly/RASposter](https://bit.ly/RASposter)

Acknowledgments:



Images source: Flaticon.com