Elementary pre-service teachers' game designs to promote science learning

Laura Martin Ferrer, Arnau Amat Vinyoles, Mariona Espinet Blanch

Laura.martin@uvic.cat

Universitat de Vic- Universitat Central de Catalunya

Introduction

A review of gaming education by McClarty et al. (2012) outlined the many theoretical reasons why games should be effective. Morris et al. (2013) suggested that some games may promote the development of skills, attitudes, and values that are useful for scientific thinking or practice. However we don't have enough evidences on science education.

One of the biggest issues with educational games is the inadequate integration of educational and game design principles. The balance between fun and educational measures should be targeted throughout the development starting from the design phase. (Arnab et al., 2015)

This presentation discusses how pre-service elementary teachers design game activities in a Teaching-Learning Sequences with the aim to promote science learning prior and after their first subject of didactics of science.

In this study pre-service elementary teachers design games to promote the construction of models to interpret phenomena. The main purpose is to describe changes in the evolution of game activities designed by students during the subject.

Context, Theoretical Framework and Analysis

Context

The study was conducted at Universitat de Vic (Catalunya, Spain), with a group of 64 students in their first subject matter on science teaching in elementary education.

The course met for 3,5 hours two times a week for 14 weeks. Generally, the program took a teacher-as-learner stance. It engaged preservice teachers in the practice of scientific modelling and reflected on the processes and practices of teaching and learning as participants themselves experienced them. It included 4 modules.

Module 1
Designed to **explore** preservice students' knowledge on science epistemology and science teaching-learning. **(3 weeks)**

Module 2
It focused on the **engagement in model centred instruction**. In this module I teach one lesson about games. **(8 weeks)**

Module 3
In order to cover the maximum of contents considered in the Catalan science standards, this module concerned to **modelling experiences** related to ecosystems including some games about this topic. **(3 weeks)**

Module 4
Final reflection and evaluation and co-teachings. **(1 week)**

One of the relevant activities in this course is to design, in small groups, a TLS of 5 activities (one had to be a game activity) focused on a science content topic (heat, friction, sound, light or buoyancy). TLS, were submitted to student analysis, reflection and modification during the semester course in order to reflect the new knowledge acquired through instruction.

Analysis

Through an inductive-deductive procedure used within a content analysis approach to textual data analysis (Mayring, 2000), 4 different dimensions were identified as well as the different categories.

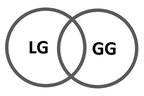
- Didactic function of game activities in the TLS
- Purposes of the game activities
- Rules; group, time, space and materials
- Actions; game actions and scientific activity actions

Theoretical Framework

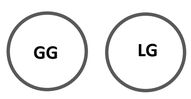
Figure 1.: Learning Cycle
Source: Jorba & Caselles (1997)

Phase	Function
Exploration	Evidencing what the students' previous ideas are. It also allows to make explicit and to negotiate the learning objectives so that the students represent them
Introduction of new information	Obtain new information in different forms (readings, observations, etc.) to help build new knowledge.
Structure	Integrate new knowledge into the existing network through synthesis and new knowledge restructuring activities.
Application	Transfer the knowledge learned and apply it to the resolution of a problem or a practical situation in different contexts.

Figure 2.: Relation between Learning and Game Goals.
Source: Adapted from **Wilson et al. (2009)**



1)different game and learning goals, but you need to use or apply scientific knowledge **during** the game.

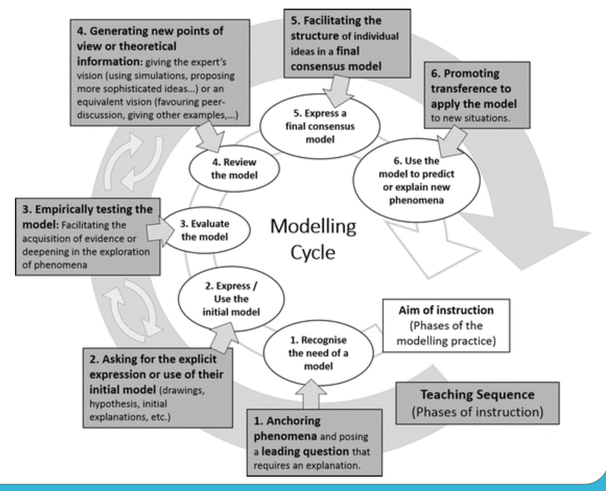


2) game activities propose the use, review or expression of the scientific model **after** playing.

Figure 3.: Structure of actions in games
Source: Adapted from **Van Nimwegen et al. (2012)**

Player Actions	Description
Perceptual action	Actions with your senses (Observe, listen, read, touch…)
Mental action	Actions with your mind. (Reasoning, thinking, deciding, choosing…)
Physical action	Moderate or intense actions with your body. (Manipulating, walking, throwing objects, jumping, running…)

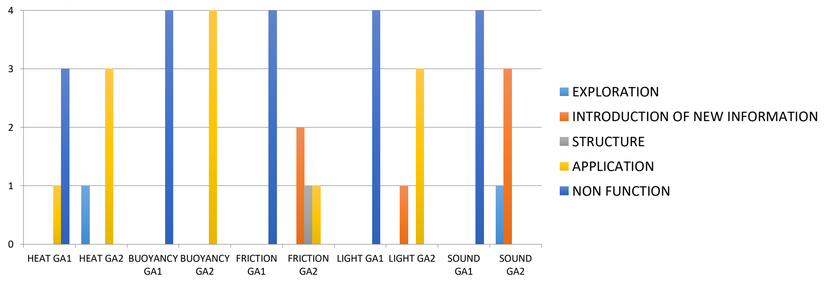
Figure 4.: Modelling Cycle
Source: Couso & Garrido-Espeja (2017)



Results

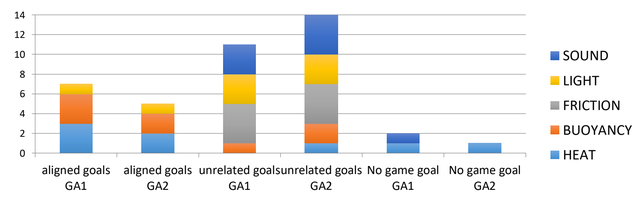
Changes in the Didactic function of Game Activities (GA) in TLS

Figure 5.: Didactic function of games activities in TLS1 and TLS2, according to scientific topics. Categories were based on Learning cycle (Jorba & Caselles,1997). In TLS1 95% of Game Activities have non didactic function, pre-service teachers design isolated activities. In TLS2 50% of the game activities have an application function and 30% have an introduction of new information function.



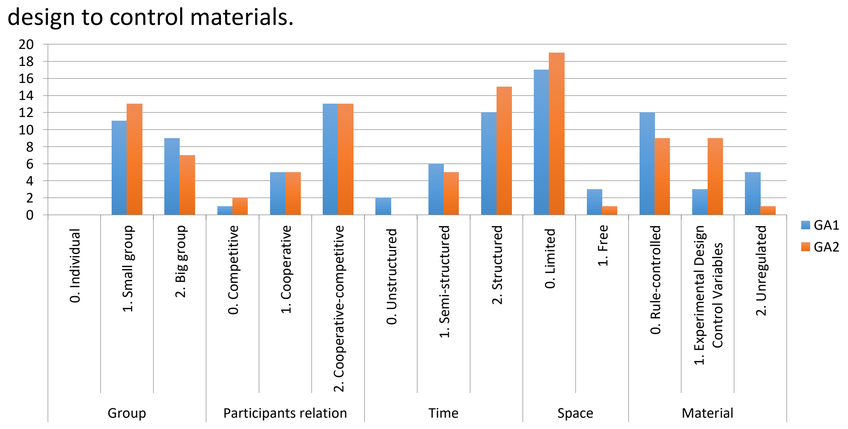
Changes in the Purposes of the Game Activity (GA)

Figure 6.: Relation within Learning Goals and Game Goals in GA1 and GA2, according to scientific topics. Based on sentiment of alignment (Wilson et al. 2009). 25% of heat GA and 25% of buoyancy GA have changed from aligned goal to unrelated goal.



Changes in the Rules of Game Activities (GA)

Figure 7.: Rules of GA1 and GA2. 80% of GA introduce rules or experimental design to control materials.



Changes in the Actions of Game Activities (GA)

Figure 8.1.: Game Actions of GA1 and GA2, according to student groups and scientific topics. Categories were based on GameDNA (Van Nimwegen, et al.2012). In the following figure we can see which actions are most present in each Game Activity. 60% of GA do not change, 15% of GA change completely, and 25% of GA incorporate mental actions.

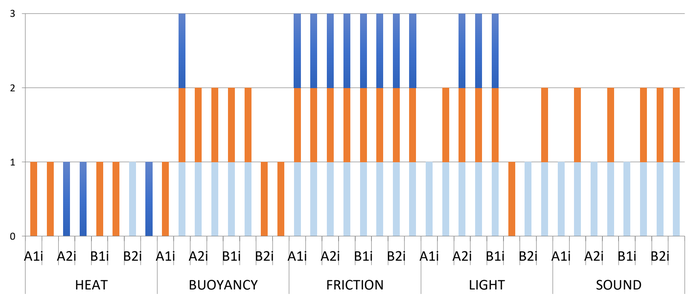
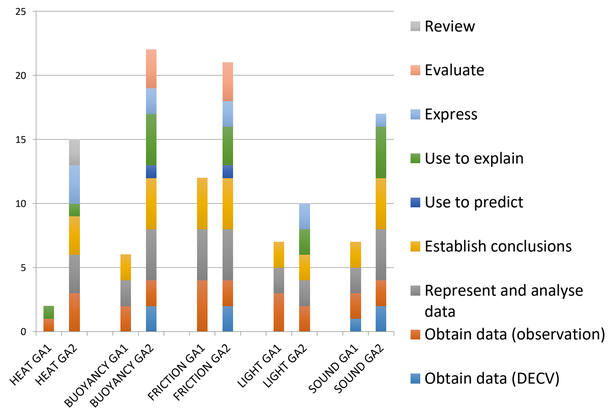


Figure 8.2.: School Scientific Activity Actions of GA1 and GA2, according to scientific topics. Categories were based on Modelling Cycle (Couso & Garrido-Espeja, 2017) and the areas of action in school science activity.

Related to facts and data, 25% of GA incorporate the Experimental Design of Control Variables to obtain data.

In relation to the area of ideas, 70% of game activities incorporate actions in relation to ideas.



Conclusions

The results show that the principal changes between initial and modified Game Activity are:

- At the beginning of the subject, students design isolated activities in the Teaching-Learning Sequences, at the end, preservice teachers mainly use GA for application or introduction of new information.
- We found two types of GA regarding the link between the game and the learning objectives; 1) Scientific ideas are used and reviewed after the game objective has been completed; 2)Players need to use or apply scientific knowledge to play. All sound and friction GA are in this second group. But the purposes of the activities don't change significantly during the course.
- Regarding the rules, the GAs are more structured, time and materials are more regulated through the rules. They mostly incorporate the Experimental Design of Variables Control.
- During the course, preservice teachers incorporate mental actions in their GA designs especially in relation to use the model to explain phenomena, and also to express, evaluate or review scientific ideas to construct models to interpret phenomena.

Overall, these results showed that pre-service elementary teachers were focused on modifying educational principals, rather than on game design principles.

REFERENCES:

- Arnab, S., et al. (2015). Mapping learning and game mechanics for serious games analysis. *British Journal of Educational Technology, 46* (2), 391-411.
- Couso, D., & Garrido-Espeja, A. (2017). Models and Modelling in Pre-service Teacher Education: Why We Need Both. Cognitive and Afective Aspects in Science Education, Springer, 245-261.
- Jorba, J. y Casellas, E. (1997). Estrategias y técnicas para la gestión social del aula. Vol. I: La regulación y la autorregulación de los aprendizajes. Barcelona: UAB-Síntesis.
- Mayring, P. (2000) Qualitative Content Analysis. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research,* 1(2). http://nbn-resolving.de/urn:nbn:de:0114-fqs0002204
- McClarty, K. L., et al. (2012). A Literature Review of Gaming in Gaming. *Gaming in Education*, 1-36.
- Morris, B. J., et al. (2013). Gaming science: The «Gamification» of scientific thinking. *Frontiers in Psychology*, *4*.
- Van Nimwegen, C., et al. (2012). GameDNA: A method to structure player actions in serious games. *Proceedings of the European Conference on Games-based Learning*.
- Wilson et al.(2009). Relationships between game attributes and learning outcomes: Review and research proposals. *Simulation and Gaming*, *40*(2), 217-266.