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Elementery Pre-Service Teachers' Conceptions on Gamification in Science Education

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Abstract

This presentation discusses a preliminary exploratory research that was carried out in an elementary pre-service science teacher education course. Our courses follow the ideas of Abell et al (2006). That is, the course promotes reflection on how pre-service teachers learn science, how science is taught to them, how they teach science, and what other authors have said about science [1]. The main purpose of this study is to explore the pre-service teachers' intuitive ideas regarding the use of gamification in teaching science in elementary school. Data was collected using two open-ended questionnaires, designed to explore the conceptions of students about games in science education and to explore the ability of pre-service teachers to design science games in a didactic sequence. Our results suggest that elementary pre-service teachers have certain conceptions about the emotional benefits of using games in education. They also show that teachers tend to design reproductive and close-ended science games, instead of focusing on the importance of game methodology and designing games.

Keywords: gamification, pre-service teacher education, science games, student teachers' conceptions

1. Theoretical background

This study, which is part of a doctoral dissertation, investigates how elementary pre-service teachers use gamification in lesson plans for science subjects. This study was carried out in a science education pre-service teacher subject.

This subject features gamification, a term used to describe the act of using game elements in non- game environments to enhance user experience (Kapp, 2012) [2]. Leisure-like activities are one of the main and most effective means of development for children as they, through games, are provided with a space for experiencing, experimenting, exploring, trying, and, especially for interacting with objects and people around them. All of this, in turn, satisfies children's needs of knowledge and action (Cortiella, LL. 2010) [3].

From our point of view, and following Morris et al. (2013), [4] games are cultural and educational tools for science education. Incorporating games to science education, however, requires careful consideration of their strengths (e.g. intrinsic motivation) and weaknesses (e.g. weak links with science content). In order to obtain the maximum benefit, games, like any other tools, need to be used in the correct way at the appropriate time.

Our science education subjects follow Abell et al. (2006) [1], who propose a critical reflection of how pre-service teachers learn science, how they are taught science, how they teach science, and what other authors have said about science. Alexakos (2015) [5] reinforces this idea with the notion of *reflexivity*, which fosters pre-service teachers' reflection in order to uncover mental and social structures with the goal of improving their teaching performance. In our study, specifically, we hypothesize that promoting self-reflection regarding the use of games in science lesson plans among elementary pre-service teachers will help them build new methodological criteria, not only to teach science, but also to use games in an educational context.

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2. Key objectives

Our main goals are:

- To explore the pre-service teachers' intuitive ideas regarding the use of gamification in teaching science in elementary school.
- And, more specifically, to analyse the design of games and educational sequences that pre-service teachers have created.

3. Methodology

This is a qualitative study based on the design of lesson plans, that is, the hypothetical planning of teaching based on sequences of activities with the aim of working one or several scientific ideas. 10 didactic units designed for groups of 2 to 3 students have been analyzed. The lesson plans revolve around five scientific topics: heat, friction force, sound, light and buoyancy.

The lesson plans have been analyzed based on Qualitative Content Analysis described by Mayring (2014) [6] from an inductive category formation. Therefore, the preliminary categories come from the data itself not from the theoretical framework. After that, the categories has been compared with the literature of reference creating new categories and eliminating others.

4. Findings

From the analysis of the games in the lesson plans 6 categories have emerged: the position of the game within the lesson plan; the cultural context of the game; the scientific activity dimension; the simulation of the scientific activity; the need for knowledge of the game to win; and, finally, participation.

The first of the six categories analyzed is the position of the game activity within the didactic sequence, in other words, where the game is planed in the lesson plan. In Figure 1 we can observe that 7 out of 10 lesson plans analyzed have the game in the last position to verify the new knowledge is learned.

Regarding the cultural context of the game, as shown in figure 2, 8 out of 10 games are adaptation of well-known games, such as: crosswords, kahoot, wordsoup, stringstring and gymkhana. In the 2 remaining designs we have not identified any similarity with any popular game. In fact, rather than games, we could recognize them as science activities focused as a challenge.

Fig. 1 Position of the game activity

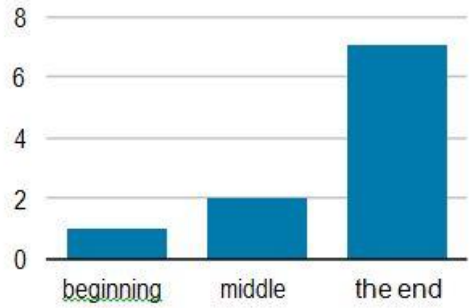
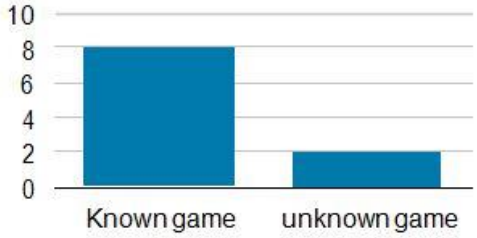
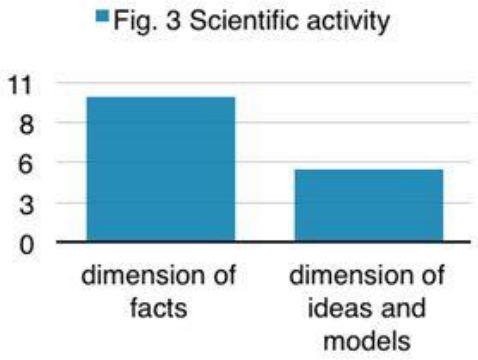


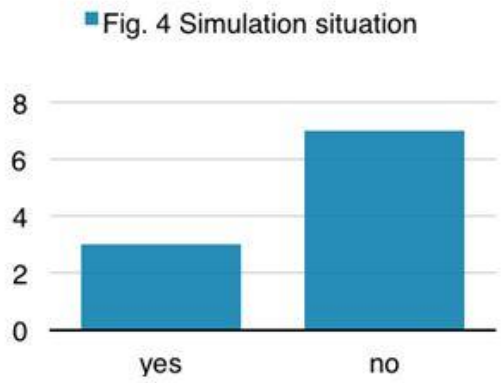
Fig. 2 Cultural Context



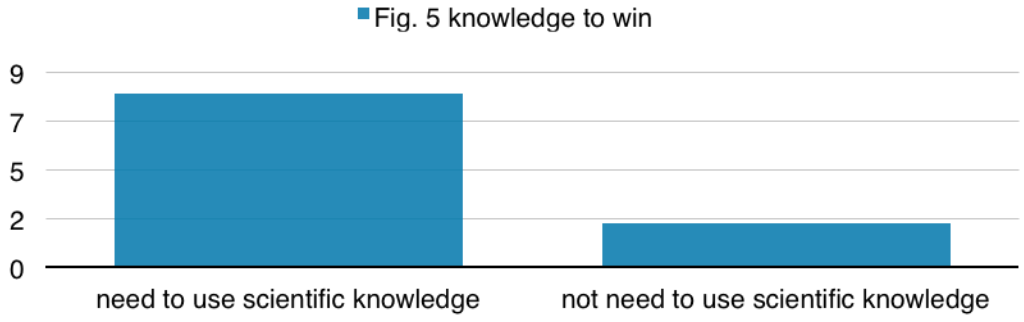
According to National Research Council (2007, p35) [7]: "science learning always assumes that there is a strong basis of factual knowledge and conceptual development in the science curriculum, and that the goal of any methodology for teaching is to facilitate student learning and understanding of this content, as well as developing their skills in, and understanding of, the methods of scientific observation, experimentation, modeling, and analysis". From our point of view, it can be inferred from this quote that science education work on two dimensions: on the one hand, data and facts; on the other hand, models and explanations. Both dimensions are required to develop an authentic scientific activity. As can be seen in figure 3, the scientific dimension that is taken into account in the game is more focused on the dimension of fact and

data than the dimension of ideas and models. All games designed, turn around observations and descriptions of what is happening in specific scientific phenomenon. In contrast, only 5 of these games promote scientific reasoning based on the reflection of scientific ideas to end up model and reach the school scientific model.
Represented in Figure 4, we see that there are 3 games that allow us to place in a simulated situation to make predictions, manipulate variables and understand complex systems, just like scientists who make authentic science.

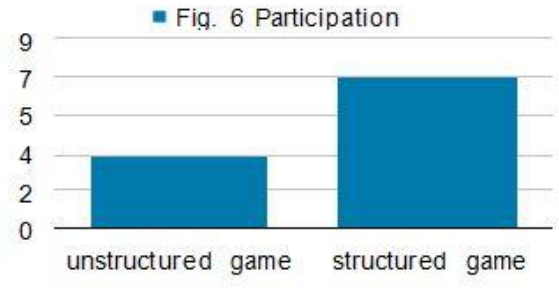




We can also observe, in Figure 5, two different types of games. In the first one, it allows us to simulate or offer a game experience that has an objective in itself, and then reflect on the scientific content of the game's actions. For example, in the lesson plan is suggested to play the string sword with gloves of different textures with the aim of dragging the opposing team to cross the line of the ground. Then students propose reflect on the friction force.
The second kind of game, which corresponds to 8 of the designs analyzed, is a game in which reflecting on a particular scientific fact or scientific idea is the goal to win.



In Figure 6, we can see that there are 7 out of 10 designed games that are highly structured games and therefore, the student agency is low. From a sociocultural perspective, participation can be described as a dialectical relationship between agency□structure. According to Tobin (2007), [8] without structure, there can be no agency and without agency. Therefore, it is important to keep in mind that structures promote and constrain the agency of participants.
Even so, on four occasions the games contemplate a later reasoning part to reflect about scientific content that is worked in each case. In contrast, 3 games, despite having clear game goals, they allow us more variables and therefore the participants' capacity for action is higher.



5. Conclusions

Our results show that pre-service elementary teachers design science games on the basis of games they already know and they adapt these games to specific science content. They normally do so in order to design post-assessment games that check for the learning occurred during the previous learning session. These games are highly structured in terms of norms, in most cases, and they allow for little room for student action. However, some of these games do make room for post-reflection on the science concept that has been targeted in the lesson.

The other results are less conclusive and we believe that more research on this topic is needed before we can clearly define the teachers' conceptions on gamification in science education.

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