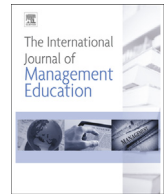


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## Research Notes

## Teaching operations research to undergraduate management students: The role of gamification



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## ABSTRACT

Gamification has been successfully applied in some educational environments, however there is a lack of studies considering gamification applied to Management university courses. In this paper, the experience of applying gamification in an Operations Research/Management Science course taught to undergraduate management students will be described. The use of challenges, points, personalized feedback, badges and leaderboards was considered to implement the most important game mechanics and related dynamics. It was possible to observe an increase of students' participation in classes, an increase in the percentage of approved students and a better assessment of the course made by the students. Some recommendations on how to implement an Operations Research course for management students are also given.

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## 1. Introduction

Games have been a fundamental part of human civilization, and the first written history of human gameplays can be traced back more than three thousand years ago (McGonigal, 2011). In modern society a vast majority of the population is playing games, feeling rewarded by participating and taking action in games and feeding needs that real world is unable to satisfy (McGonigal, 2011; Reeves & Read, 2009). Everyone that has already played some game has felt the sense of being totally focused in something, engaged in every single moment, having a feeling of accomplishment and success (McGonigal, 2011; Reeves & Read, 2009; Yee, 2006). And if this passion is shared with many other people, games also give us the feeling of belonging to a community (McGonigal, 2011). Gamification is present in our daily lives, although sometimes we do not even recognize it. One of the most disseminated examples of the use of gamification with the objective of changing people's habits is the *Piano Staircase* at the Odenplan subway in Stockholm. The main idea was to convince people to use the stairs instead of the escalator or elevator, and make the use of stairs a funny thing by turning it into a giant piano (TheFunTheory, 2009). Each step of the staircase would play a musical note when it was stepped on. Another example is *Superbetter*, aiming at helping people recover from an illness and achieving health goals by belonging to a community and playing a game (McGonigal, 2016). The badges that are given to acknowledge your achievements when you contribute with reviews in *Tripadvisor* are a tool to convince you to keep contributing with more and more reviews (staying enrolled in the game).

Hundreds of millions of people play regularly online massive multiplayer games (Reeves & Read, 2009). About 67% of teenagers regularly play online games, and players aged 18 to 22 play on average around 25 h per week (Williams, Yee, & Caplan, 2008). Students that are now entering university are more and more acquainted with gaming experiences. They

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like to have instant feedback on their actions, as well as being able to progress in the game even if things are not done in a perfect way all of the times (Reeves & Read, 2009). And most of them are engaged in such a way in some of these games as they will never be in any of their university courses. Gamification has already been successfully applied in different educational environments (Caponetto, Earp, & Ott, 2014; de Sousa Borges, Durelli, Reis & Isotani, 2014; Dicheva, Dichev, Agre, & Angelova, 2015; Hamari, Koivisto, & Sarsa, 2014), but there is a lack of studies considering gamification applied to Management university courses. This paper describes the experience of having a gamified version of an introductory operations research (OR) course taught to the first year students of a bachelor's degree in management, and the results achieved. This paper is organized as follows: after this introductory section, section 2 presents a literature overview. Sections 3 and 4 present the methodology and materials used, including a brief description of the course. In section 5 a comparison between the gamified and non-gamified versions of the course is made. Section 6 presents main results. Section 7 presents some advices on how to gamify an OR course. Section 8 acknowledges the limitations of the current work, and suggests possible paths for future work. Section 9 presents some concluding remarks.

## 2. Literature overview

### 2.1. Gamification

Gamification can be defined as the use of game elements and game-design techniques in non-game contexts (Werbach & Hunter, 2012). But what characterizes a game? There are several different definitions, although they converge in some points (Miller, 2013): a game is played by choice; it encompasses goals, rules, feedback, challenge, surprise, understanding. Game playing is associated with trial, error, failure and eventual success through practice, experience, reflection and learning (Buckley & Doyle, 2014). An introduction to the basics of gamification can be found in the published work of Robson, Plangger, Kietzmann, McCarthy and Pitt (2015), in two very interesting books by Kapp and co-authors (Kapp, 2012; Kapp, Blair, & Mesch, 2014) and a collection of papers considering very different features on gamification (Reiners and Wood, 2015).

Bedwell, Pavlas, Heyne, Lazzara and Salas (2012) propose nine attribute categories associated with games: Action language; Assessment; Conflict/Challenge; Control; Environment; Game fiction; Human interaction; Immersion; Rules/goals. Table 1 presents a brief description of each one of these attributes (Bedwell et al., 2012; Landers, 2014).

According to Landers (2014), core to the definition of gamification is the fact that the game is not created in gamification because a pre-existing process (such as a classroom or training program) already existed. It is this pre-existing process that is augmented with features borrowed from games (Landers, 2014). Gamification is a process that aims at increasing both intrinsic and extrinsic motivation (Buckley & Doyle, 2014), and having people engaged in working activities. Motivation can be interpreted as the desire to be involved in the activities (Kim, Park, Cozart, & Lee, 2015). Behaviors can be understood as being intrinsically motivated if they are the result of self pleasure and satisfaction (Deci, Vallerand, Pelletier, & Ryan, 1991). Extrinsically behaviors are performed considering a related consequence (Deci et al., 1991). It has been shown that especially intrinsic motivation can be responsible for promoting in students an interest in learning (Deci et al., 1991). More information regarding the effect of students' motivation on the learning outcomes can be found in Clark, Howard, and Early (2006).

The word *engagement* can have different meanings in different environments. Deater-Deckard, Chang and Evans (2013, page 22) define engagement in the learning context as “a collection of mindfully goal-directed states in which motivation arising from positive emotions serves to grab and sustain the learner's cognitive and motor competencies, typically requiring some level of effort”. In the gamification context, *engagement* refers to the active participation of the players throughout the game. If a player is engaged with the game, he will be motivated to address the challenges ahead, and will not think of dropping out. A deeper discussion about the definition of *engagement* and the effect of *engagement* in education is out of the scope of this paper (see, for instance, Bryson & Hand, 2007; Christenson, Reschly and Wylie, & Eds., 2012; Kahu, 2013). Motivation and engagement do not always go hand in hand (Kim et al., 2015): there can be motivation without engagement, since the latter comes from the effort and metacognitive regulation that one puts into the process.

Each of the game attributes described in Table 1 can be represented in a game by different concrete features, usually known as the game components. The most obvious gamification components are usually known as the PBL Triad (Werbach &

**Table 1**

Attribute categories of games (adapted from Bedwell et al., 2012; Landers, 2014).

Game Attribute	Definition
Action Language	Communication between the player and the game itself; the method by which the players make their intent clear to the game.
Assessment	The measurement of achievement within the game, feedback given throughout the game, the way in which game progress is tracked.
Conflict/Challenge	Presentation of problems in games, the nature, difficulty and uncertain aspects of these problems.
Control	The degree to which players are able to alter the game, and the degree to which the game alters itself accordingly.
Environment	Representation of the physical surroundings in which the player is immersed during the game.
Game fiction	The nature of the game world and story.
Human interaction	The degree in which players interact with other players in space and time.
Immersion	The player's perceptual and affective relationship with the game fiction.
Rules/goals	Clearly defined rules, goals, information on progress toward the goals.

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