Creating Student Interaction Profiles for Adaptive Collaboration Gamification Design

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ABSTRACT

Benefits of collaborative learning are established and gamification methods have been used to motivate students towards achieving course goals in educational settings. However, different users prefer different game elements and rewarding approaches and static gamification approaches can be inefficient. The authors present an evidence-based method and a case study where interaction analysis and k-means clustering are used to create gamification preference profiles. These profiles can be used to create adaptive gamification approaches for online learning or collaborative learning environments, improving on static gamification designs. Furthermore, the authors discuss possibilities for using our approach in collaborative online learning environments.

KEYWORDS

Adaptive Gamification, Collaborative Learning, Gamification, Interaction Analysis, K-means Clustering, Profiling, Software Engineering Education

INTRODUCTION

Collaborative learning, or the cooperative activity of students working together towards a specific learning goal with the teacher as a facilitator (Bruffee, 1995; Dillenbourg, 1999b), has become an increasingly topic important in education (Okamoto, 2004). This collaborative approach to education has been shown to develop critical thinking, deepen the level of understanding and increase the shared understanding of the material (Gokhale, 1995; D. W. Johnson & Johnson, 1999; R. Johnson & Johnson, 1994). Computer-supported collaborative learning (CSCL) extends and facilitates this cooperation by using electronic communication tools (Dillenbourg, 1999a). CSCL has several benefits, including wider participation for knowledge building, and improved student productivity and satisfaction (Resta & Laferrière, 2007).

Computer supported collaboration is also essential in software engineering education, because working and efficiently collaborating teams is at the basis of software engineering industry (Coccoli, Stanganelli, & Maresca, 2011). The impact of collaboration has been studied in both physical classrooms (Alaoutinen, Heikkinen, & Porras, 2012) and in online environments (Dewiyanti, Brand-Gruwel, Jochems, & Broers, 2007) with positive course outcomes. However, the people who benefit most from this collaboration do not always interact (Knutas, Ikonen, & Porras, 2013).

In recent studies it has been shown that students can be guided towards educational goals like collaboration by using gamification (Glover, 2013), which is the application of game-like elements...
to non-game environments (Deterding, Dixon, Khaled, & Nacke, 2011; Groh, 2012). Approaches that use some elements of gamification have been shown to increase student collaboration (Moccozet, Tardy, Opprecht, & Léonard, 2013) and the motivation towards achieving course goals (Sheth, Bell, & Kaiser, 2012) in educational settings.

Although we instinctively recognize than games and fun are tightly related, both concept and their interrelation are quite slippery to define (Caillois, 1961; Crawford, 1984; Huizinga, 1950; Juul, 2003; Rollings & Adams, 2003; Salen & Zimmerman, 2005). The investigation of these issues has led neuroscientists and cognitive psychologists to examine how playing a game and learning are connected (S. Johnson, 2004; Miller, 1956). The basic observation is that humans have always used games as playgrounds for learning and exercising safely specific skills. During this process, human brain secretes endorphins (which makes a game an enthralling and fun activity), is highly focused on recognizing recurring patterns in problems, and on creating appropriate neural routines to deal with them. Once the pattern is fully caught by the player, the game becomes boring, but the skill has been accurately acquired. In a certain sense, we could say that “Fun is the emotional response to learning” (Crawford, 2003) and that the first and main reason for a (video) game to exist is to provide fun to its players (Koster, 2005), that is achieved not only through alluring game mechanics, but also by providing an environment that fosters immersivity (Csikszentmihalyi, 1991; Fullerton, 2008; Salen & Zimmerman, 2004).

Our proposed solution is to use an evidence-based method for deciding which gamification elements to apply and how to apply them. In this method we build collaborative behavior profiles for students by using interaction analysis and teamwork profiling surveys. These profiles and the collected profiles of interactions can be used to model how different students react to gamification elements and the available goals in order to create or improve adaptive gamification systems.

In this paper we detail our profiling method and present a case study where we profile the collaborative behavior patterns of students who participated in a software engineering course. We also present our plan of how to use these profiles to create custom user-centric gamification approaches for a gamification system, with an ultimate goal of using them to improve collaboration in CSCL environments. Specifically, our research questions in this study are:

1. What kind of collaborative interactions are present on a collaborative software engineering course?
2. Do these interactions have repetitive patterns that can be used for profiling?
3. Which team worker roles and gameplay styles the profiled students prefer?
4. How can these profiles be used to improve gamification systems?

In the next section we review previous approaches to gamification in education. After that we detail our research setup, methods of analysis and the research results. In discussion we consider the implication of these results and how these results can be applied to a gamification CSCL system. The paper finishes with conclusions.

**GAMIFICATION APPROACHES IN SOFTWARE ENGINEERING EDUCATION**

Gamification, at its core, is the use of game design elements in a non-game environment (Deterding et al., 2011). However, effective gamification is about using these game elements along three important principles, in order to satisfy users’ three innate needs for intrinsic motivation (Groh, 2012), which were originally adapted by Deterding (2011) and Schell (2011) from Deci and Ryan’s (1985) self-determination theory. The three principles are (Groh, 2012):

- **Relatedness**: The universal need to interact and be connected with others.
- **Competence**: The universal need to be effective and master a problem in a given environment.
- **Autonomy**: The universal need to control one’s own life.
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