Structural Gamification for Adaptation based on Learning Analytics

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Gamification is widely used to increase learner motivation when using a learning environment. Recent research has shown that gamification should be adapted to learner profile, as learners do not respond at the same manner to game elements, and in some cases, learners can feel demotivated by certain game elements. We propose a structured approach for gamification, named structural gamification that allows adapting game elements without changing the educational content or altering the functioning of the learning environment. This approach relies on three levels of abstraction: motivational strategies (high-level tactics or techniques to encourage learners to participate in the learning process), game elements (specific implementations of motivational strategies), and game element instances (contextualised instantiations of game elements). Using this approach, adaptation can occur on any of the three levels, either by changing motivational strategy, or game element, or by modifying the game element instance directly. This allows for a more fine-grained adaptation that is based on three components: the learner profile, interaction traces with the learning environment, and contextual information. Our future work will be focused on the analysis of learner engagement during the learning activity through their interaction traces to allow for dynamic adaptive gamification.

Keywords: Motivation; Adaptation; Gamification; Learning Analytics

1. Introduction

Gamification, defined as "the use of design elements characteristic of games in non-game contexts" (Deterding, Dixon, Khaled, & Nacke, 2011), has been increasingly used in education to increase learner motivation and engagement. Studies have shown that to be effective, game elements should be adapted to learners' expectations, as learners are motivated by different game elements (Lavoué, Monterrat, Desmarais, & George, 2018). To be able to adapt gamification to learners, we employ structural gamification (Kapp, 2013) that we define as "the addition of a gamification layer to a system without alteration or changes to its content". This layer aims to engage learners with the content and the tasks

supported by the learning environment. The advantage for adaptive gamification is that structural gamification allows us to modify game elements without changing the system or redesigning the educational content.

We applied structural gamification with teachers in a real educational setting as a part of the Ludimoodle project, which aims to enhance learner motivation for mathematics at a secondary school level. In this context, teachers already have educational content that they do not want to modify in order to gamify it. Because we separate the educational content and the gamification layer, teachers do not have to make changes to their lessons when game elements are changed for adaptation.

2. Adaptive gamification

We identified that adaptation of gamification can be made on three levels of abstraction.

The most abstract level is the *motivational strategy* defined as "high-level tactics or techniques to encourage learners to participate in the learning process" (Rasmussen & Nichols, 2008). This level contains such abstract concepts as “Rewards” (giving learners virtual rewards),”Goals” (providing clear goals for learner progression), or “Time” (creating time pressure with timers or schedules). Many studies show the differences in user motivation from the application of different motivational strategies (Orji, Tondello, & Nacke, 2018). At this level, adaptation is made by recommending or changing motivational strategy. For instance, if a learner is not motivated by a rewards system, we can consider trying a goal based one.

The second level is the *game element* level. Each motivational strategy can be implemented using different game elements. For example, the rewards strategy can be implemented using badges or points. Various studies show the differences in the effects of game elements from a same strategy. For example, Denny et al. show how student motivation varies between point based and badge based rewards (Denny, McDonald, Empson, Kelly, & Petersen, 2018). Adaptation on this level corresponds to recommending

the most appropriate game element from a given strategy. For example if a learner feels demotivated by a points system, consider using badge type rewards instead.

At the third level are the *game element instance*s. They are the instantiation of game elements according to the context and learner profile. Various properties can be instantiated with the game element, such as the visualisation and general functioning rules (Hallifax, Serna, Marty, & Lavoué, 2018). When adapting for this level, designers can tweak the various properties. For example, consider the badges in Duolingo and Khan Academy, both are from the same motivational strategy (Rewards), and the same game element (Badges). However, they look and work quite differently, in Duolingo each badge can be obtained multiple times by repeating exercises. In Khan Academy, badges show milestones that learners can unlock once. For example, if when using a goals system, the learner finds the goals to be too easy, it may be possible to motivate them by making the goals harder.

3. An architecture for adaptive gamification

We propose an architecture to adapt gamification based on three kinds of data collected by the system: (1) data about the learner through a learner profile for adaptation before the learning activity, (2) the interaction traces of the learner with the system for dynamic adaptation during the learning activity and (3) contextual information about the domain or the gamified content. The adaptation engine uses rules that provide links between user profiles, interaction traces, contextual information, and related game element instances. It proposes a list of adapted game element instances that a Control UI (machine or teacher) can choose from for the learner.

4. Future work

Regarding the adaptation process, we have already proposed a model for adaptive gamification based on learner profile (Lavoué et al., 2018). However, although the analysis of learner engagement through its interactions with the system has been widely studied (Henrie, Halverson, & Graham, 2015), it still

remains a challenge for adaptive gamification. Our future work will focus on dynamic adaptation based on the analysis of learner interaction traces.

5. Acknowledgements

This work is a part of the *LudiMoodle project* financed by the *e-FRAN Programme d'investissement d'avenir*, operated by the *Caisse des Dépots*.

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