An Investigation of the Impact of Gamification on Novice Programmers' Achievement and Learning Experience

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Abstract: Gamification is becoming a popular classroom intervention used in computer science instruction. It is used to encourage student behaviors to improve learning experience and achievement. However, existing studies have mostly implemented reward-based game elements which have resulted to contrasting behaviors among students. Meaningful gamification, the use of game design elements to encourage users build internal motivation is contended to be a more effective approach. The work presented in this paper explored how the use of a tool founded on meaningful gamification affect the achievement and learning experience of novice programmers. It also studied how different user types, as characterized by the Gamification User Types Hexad, vary in their response to different game design elements.

Keywords: gamification, meaningful gamification, novice programmers, CS1

1. Introduction

Games are used as models for engaging learners (Kapp, 2012). Gamification is the use of game design elements in non-game contexts (Deterding et al., 2011). However, implementations usually adopt reward-based gamification which is effective in contexts that call for short-term behavior change (Nicholson, 2015). Nicholson defines *Meaningful Gamification* as the use of game elements in non-game contexts to help a user build intrinsic motivation (Nicholson, 2015). This is built on the Self-Determination Theory (SDT) (Deci and Ryan, 2002) which states that intrinsic motivation has 3 components: 1) mastery – learning for competence; 2) autonomy – having control of paths; and 3) relatedness – refers to one's social engagement. Educators can capitalize on this in creating gamified environments that could develop students' intrinsic motivation. Also, people can exhibit varying behaviors once subjected to the same situation due to personality differences (Paunonen and Ashton, 2001). This is something to note when designing interventions aimed at reaching a wider range of users.

2. Research Objective

The work presented here investigated how a tool founded on meaningful gamification affects the achievement and learning experience of novice programmers. Moreover, the research meant to explore how different user types, as determined by the Gamification User Types Hexad Scale (Marczewski, 2015), vary in their response to various game design elements.

3. Methodology

The main objective of the study was to experiment on the use of gamification in an introduction to programming (CS1) class. To realize this, a gamified programming-based activity management system specifically designed for CS1 classes was developed. The system was designed with game design elements selected by purposely mapping them to the components of the SDT. The elements are feedback cycles, freedom to fail, and progress to support mastery; control to enable autonomy; and

collaboration for relatedness. These were implemented as system features and user interactions with them were logged. An expert evaluation was conducted to draw feedback from CS1 instructors with regards the implementation of the different game design elements. Two iterations of testing were conducted on different sets of students. Data on the students' interactions with the different game design elements were analyzed to come up with characterizations of their use of the system.

4. Findings

The primary motivation of the research is to contribute quantitative accounts of how meaningful gamification impacts novice programmers' achievement and learning experience. Results show positive effects on achievement of both strong and weak students. Control, feedback, and freedom to fail helped strong students get even better scores. They were much useful to the weaker students who most need the opportunity to improve. The effect on learning experience was favorable. The score was found to be a useful form of feedback despite user types. Freedom to fail through re-attempts was used by everyone. Additionally, varying user types take control of which items they answer in the activities.

5. Future Plans

Moving forward, the intention is to explore further how gamification or game-based learning environments could be better leveraged in education to support and enhance the learning experiences of learners. Identifying particular game elements that positively impact learning environments and achievement in specific contexts is something of interest.

6. Challenges and Questions

Some questions of interest are: (1) What particular game elements positively impact the learning experience and achievement of learners? and (2) How can a gamified or game-based learning system be designed to sustain learner engagement even beyond the novelty of their first interaction with it?

Acknowledgements

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