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Understanding the Effects of Game in Educational Environment using Game Refinement Measure

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Extended Abstract

In the recent years, there is a growing interest in gamification as well as its applications and implications in education domain because it provides an alternative to engage and motivate students during the process of learning. Whereas gamification is gaining ground in some areas such as business, marketing, and wellness initiatives, applying gamification into education area is an emerging trend. While the majority of studies report overall positive results of applying game-based elements into an education system and evaluating the effects of those elements after applying, the studies, which aim at increasing the effects of those elements in an educational context, are quite restricted. The current problems of increasing effectiveness of game elements in non-game context are it lacks a common measurement and the criteria for assessing that measurement. This is a reason why the authors of gamified systems do not know whether the applied elements make positive effects or not until they do an analysis on users' data and surveys. Moreover, it is really difficult to know exactly what elements and what reasons caused that. Therefore, finding a common measurement and the criteria are needed.

In educational games, the purpose of those games is twofold: (i) to be fun and entertaining, and (ii) to be educational. Therefore, assessments of educational games must be considered on two aspects which are entertainment and educational impact. In our works, we try to analyze and assess some popular game elements which have been used in popular gamified systems. In our studies, we first focused on the entertainment aspect of the gamified system to measure the attractiveness of game elements in this system. We use game refinement theory, which provides a common measurement for quantifying attractiveness of a considered game and be successfully applied into various types of game, in order to measure the attractiveness of game elements in gamification domain. We conduct many analyses based on game refinement measure for understanding more the effect of considered game elements.

In the thesis, we aim at analyzing game elements in two popular learning gamified platforms which are MindSnacks and Duolingo. These platforms have been awarded as "Honorable Mention". This award is "Best of Class" award for the good technologies. According to the book of UDL Technology, the gamified learning applications are preferred to choose for learning language users

rather than non-gamified applications. Therefore, in our studies, we aim to conduct some analyses to discover and explain how a game element in the gamified applications can attract learners by using a game refinement measure

In the first study, we first focus on analyzing the effectiveness of game element Badge in Duolingo. The result shows that the game refinement values of Badge in popular language courses of Duolingo are lower than sophisticated games. This result is reasonable because Duolingo is a serious environment which means the game elements are not used for making the entertainment environment as fun games. Those values fall into the range between 0.02 and 0.03 which are proposed as the suitable range for *GR*-values in gamification applications. Moreover, in this study, a milestone technique was highlighted and its effect also is analyzed. After analyzed, the game refinement trend in the most popular course indicated that the increase of challenge in each milestone aims at adapting the advancement of learners' skill. This trend also express the effect of the course structure that making rest stops for a long learning journey. Moreover, by doing a brief experiment on a course structure, we discovered that Duolingo is enjoyable for newcomers who start from the first milestone, however, less enjoyable for advanced users who start at the second or the third milestone.

In the second study, we continue our previous research by doing the comparison between the course structures in different language courses as well as in different applications to see the course structure's effects in the interesting of beginners and the engagement of users for a considered game element. The first result shows that the division and number of learning material in a structure have an influence on the attractiveness of the considered course. Furthermore, based on the slope of game refinement in the course structure, we have figured out that if the slope is more sloping, users are easier attracted by other game elements. Moreover, the decrease of game refinement value through each milestone can express the decrease of user engagement to the game element. Furthermore, in the comparative study between MindSnacks and Duolingo, the differences of *GR*-values between these applications contribute to the significance in interpreting learners' enjoyment points. The comparison pattern of *GR*-value shows that MindSnacks' learners enjoy the use of gamified learning approach rather than Duolingo.

The third study aims at exploring the effects of the game element Winning Streak on the learning process of users in Duolingo. In this research, we first figure out the attractiveness of Winning Streak individually. Then, we discover its contribution in the improvement of entertainment aspect. For the experiment, we collected data of 2000 users to measure a game refinement value of each milestone in the most popular language course. The result of the first consideration has shown that Winning Streak helps users enhance their normal learning activity to serious game activity. That means users has interested their learning activity with Winning Streak. The longer winning streak is more precious for users in Duolingo. After compared the game refinement value trend of Winning Streak and Badge, we recognized that Winning Streak helps Duolingo improve its enjoyment when the attractiveness of Badge decreases. Therefore, the sec-

ond analysis was conducted in order to clarify this viewpoint. According to the difference of GR -values between two kinds of users, the results show that the streaking-users are more attracted rather than the normal users. Additionally, by comparing the increase ratios of attractiveness and the streaking-users percentages between milestones, the results also expressed that a winning streak is more significant for advanced users rather than beginners

After we understand the effects of game elements and gamification techniques, we apply our experiences and game refinement measure into improving the entertainment aspect of our own game which is cybersecurity awareness training game. This game is designed by using activity theory based-model of the serious game and a story game play. The game demo is played and evaluated by 10 participants. The evaluation results indicated that the story game play can help players improve their understanding of cybersecurity problems and resolutions. However, it is rated as not interesting. Therefore, we have used our understanding and game refinement measure to improve the entertainment aspect of this game by designing the learning structure. As the result, a new version of the game has the game refinement value falls into the appropriate range of sophisticated games.