CREU 2015-2016 Final Report:
**Teaching Coding Concepts through Gaming**

CREU Team Mentor Nanette Veilleux, Simmons College
CREU Team Member Jazzmine White, Simmons College

## Goals and Purpose

This project aims to address the lack of diversity in the STEM fields specifically in computer science. Some research suggests the racial and gender disparity is caused by lower opportunity and lesser encouragement to pursue STEM careers. This project aims to close the gap by introducing coding concepts through gamification. The idea to combine gamification and programming sprung from a session at the Grace Hopper Celebration where Shahnaz Kamberi discussed her work with a Sims like game that taught the users, teenage girls, Java.

The overall goal of the project is to determine if gamification is a viable means to teach coding and gain interests from people of color and women. During the beginning of the project, a fair amount of focus was placed on the coding curriculum. The user stepped through a series of 3 games for each topic. The first game was purely text to get the user familiar with the topic. The second, was a Scratch application of the coding concept. And finally, the last was a game with user input to score points. While it is important to make sure the quality of education was available, for the summer extension the focus shifted to incorporating more elements of gamification and attracting a more diverse test population.

In order to make gamification a greater priority, two main sources were consulted, *Gamification: Designing for Motivation* by Sebastian Deterding of Hamburg University and *Raising Engagement in e-Learning through Gamification* by Cristina Ioana Muntean of Babes-Bolyai University, Romania. After three rounds of user experience testing, the results were analysed using information from both articles. The most prevalent subject was motivation. Both articles talk extensively about the importance of keeping the user excited and integrated in the games. The user testing revealed the original games solicited very little motivation from the user. To remedy that, the games started keeping score and determining a winner leading to an increase desire to play the games. It was especially high if the user had lost a game or a friend had completed the game faster and the user wanted to "redeem" themselves. Continuing with theme of

motivation, receiving a bad score on the pretest caused some users to quit the games completely. In order to avoid that problem, automatic grading was removed from the pre and post tests. Making these changes allowed for a more cohesive and fun gaming atmosphere.

Finding a diverse test population was a major hurdle. In the first round of testing, the group was largely college age white women. Women were a target for the group but there needed to be more diversity in education and race. The strategy in the beginning of the summer extension was to work with connections from Simmons College that already had groups of young girls attending their programs. Due to email miscommunication, the plan never game to fruition. The next idea was to collaborate with local camps and libraries that had a steady stream children in a set location. Unfortunately, there were challenges to both camps and libraries. Camps had already set up their summer curriculum and those that had time did not have computer available. With libraries, there are children and computers but getting the consent forms signed would be difficult since most students use public transportation to get to the library and parents would not be around to sign.

In the end, the best course of action was to get smaller groups to participate instead of trying to find one set date and time to collect data. In public areas, where children and parents are present like a park or a playground data was collected. This was the optimal solution because the only requirement was wi-fi and one computer. And, the parents were present so consent forms were no longer an issue. The park provided a racial and gender diverse test group. There are no socioeconomic, racial or gender barriers on a park leaving a much more representative data set.

The data consisted of a demographics questionnaire, a pretest, 3 learning modules, 3 games and a posttest. Because of the testing site and paper's tendency to fly away, physical data input was replaced by a Google form allowing an easier flow to the games. The application style games were removed because in early testing many found them confusing and not enjoyable. To compensate, the removed information was included in either the accompanying learning module or game. In addition, a user ID number was added at the request of users. Some did not want their name attached to the pretest because of their low scores. The user ID number not only provided a level of anonymity it also became a unique key in the database making data analysis much easier.

## Results and Discussion

The project produced 66 completed and 12 incompleted sets of data. The participants were from almost every racial group with only Native American not included. The breakdown was 50% Black, 23% Asian, 19% Latino and 23% White. Education was not as spread with almost 70% having graduate from high school. Education level was expected to be large in that category given that many parents participated alongside their children. The same explanation follows for the rather age gap ranging from 3 to 56. For results from the pretest, the average score out of 4 was 1.455 (sd = 1.279) and the most frequent score being a 2. It should be noted that the 12 participants that did not complete the posttest were excluded from the pretest analysis as there would be nothing to compare it to in the posttest. The vast majority of participants responded correctly to the boolean subject. After interviewing participants post experiment, the reasoning behind is students in that neighborhood had already learned Algebra and the parents revisited booleans through their children's homework. In the posttest, the average score was 2.318 (sd = 1.23) and the most frequent score was 3. In almost every case scores increased.

The posttest average is lower than the 3.27 reported in the first iteration. There are 2 main reasons. First, age and education, in the first experiment all of the participants were over 18 and in college meaning their reading and comprehension levels were far above the children in the second test. Second, the environment is completely different. For the first test, the participants were in a quiet lab with no one else around. Compared to a loud public play area and add parents pressuring their children to answer correctly. When taking in all the factors the two scenarios become very different. Just looking at the data it is clear that the games increased overall knowledge of coding concepts.

The two different environments in the two tests brings up new questions to be investigated. First, their was natural competition between users. When one child completed a game another one would try to beat their time. Previously, the project used individual scoring. Using a leaderboard style scoring might provide more motivation and thus more knowledge acquired. Secondly, parents caused some anxiety among the child participants and it seemed to take away some of the game elements. Parents were more interested in whether the answer was correct and not whether the child was having fun. Comparing test scores in a high stakes testing environment and a calm one to determine the impact gamification has on the two.

## Presentations and Web Links

Demonstration Website - Used during testing:
http://anita.simmons.edu/~creu/CREU2015/demo/
Panel Presentation - Presented at the Simmons Undergraduate Symposium:
https://docs.google.com/presentation/d/1VN2eLN_5Ww7qVxxUFUmGtzKj0qUo3FanSlcZP0OzP1g/edit?usp=sharing

## Citations

Deterding, Sebastian. "Gamification." *Interactions* 19.4 (2012): 14. Web.

Muntean, Cristina. "Raising Engagement in E-learning through Gamification." *The 6th International Conference on Virtual Learning ICVL* (2011): n. pag. Web.