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**CREU 2016-2017 Final Report: Motivational Feedback in Game-Based Learning for  
Advanced Programming**

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**I) Goals and Purpose**

Our research project seeks to investigate what role motivational feedback plays in educational games. A special focus is placed on this role as it relates to gender. Game-based learning allows educators to tap into the enthusiasm that students show for computer games and bring those attitudes to the classroom. A number of serious games have been created for specific topics in CS education (see reference section), and experimental evaluations of these games have indicated that they are an effective and fun teaching tool. Besides further assessment of the extra motivation for learning intrinsic to the fun of game playing, we wanted to measure the effect of feedback to motivate students further. We wanted to know how educational game players are affected by negative feedback, positive feedback, positive and negative feedback, or no feedback, when learning advanced programming topics. Research has shown that there are fundamental differences in the ways that male and female players play computer games. Hence, effort must be invested to ensure that educational games are appropriate for both genders. We hope that our findings will help us or others create a pedagogically useful game that can be used at our institutions, as well as others, to help students in programming courses practice their skills and enjoy the fun of programming.

**II) Related Work**

There has been a good deal of research about game-based learning conducted over the past few decades, e.g. [28, 38, 15, 29, 17, 25, 2, 24, 13], including some in the context of teaching programming [3, 20, 27, 32]. Research suggests that using an educational game is a good way to interest students in programming, to motivate them to practice their skills, and to reinforce important educational objectives. Hence, we are interested in investigating the use of games in aiding students who are learning how to program. We question, however, what role feedback may play in the process.

In this work, we follow the definitions outlined in [34] in differentiating between *motivational* and *informative* feedback in education. Motivational feedback, which can be either *positive* or *negative*, focuses on reinforcing student behaviors with comments such as “Good job,” or “You could do better.” Informative feedback aims to give the students a clearer view on where they stand and how they are doing; we will be focusing on *motivational* feedback.

Our research questions are motivated by work in gender Human Computer Interaction (HCI) and computer game design. Research on the intersection of these two fields focuses on the fact that games may not be designed equally for both genders, thus putting one at a



disadvantage while using them [4]. Moreover, it is not always readily apparent what would appeal to each gender; often researchers make assumptions that turn out to not be supported by practice [21].

Our goal is not to focus on so-called “girl games” and “pink software” by fostering the design of games such as *Barbie Fashion Designer*. Such games may indeed fulfill the goal of interesting girls in using computer technology for fun, but it comes at the expense of reinforcing traditional female stereotypes [14, 12]. (Plus, at this point, almost twenty years after the creation of *Barbie Fashion Designer*, we hardly think that girls or women need encouragement to use computers or technology for fun!) Rather, we seek to create games that appeal naturally to the preferences and interests of *both* genders, instead of ignoring those of women, as so often happens inadvertently by male game designers. An added bonus of this approach is that, as it is so often the case in HCI, focusing on the needs and preferences of women isn't just female-oriented design. Rather, it's just good design, period [12].

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### III) Process

Through our investigations into previous works we did not find any games developed to teach the advanced programming topics needed to prepare students for critical Data Structure courses. We developed a game in Unity that teaches and assesses student knowledge of advanced programming topics; we focus on C++ pointers, which we find to be particularly confusing to students. To take full advantage of the game learning



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interface, we incorporated visual representations of the topic. We tried to make the game appealing to female players through the use of a storyline that included a meaningful goal, the use of facial expressions and human-like animations on our sprites.

We created two versions of the game: one that only gives the player negative feedback (when they answer a question wrong), and the other that returns only positive feedback (when the player answers correctly). Our first sessions of testing only demonstrated both methods of feedback at once. To measure the effectiveness of our preliminary game, we recruited a sample of 37 students of Brooklyn College and College of Staten Island who are in currently taking, or have recently completed, the Advanced Programming techniques course. The participants were asked to complete a short quiz before playing the game, and then another short quiz upon completion, to evaluate what influence (if any) the game has had on their performance.

#### **IV) Results and Discussion**

After testing our preliminary game (with both modes of feedback) on our sample selection of students, we gathered their feedback. Each of them took a pre and post-game quiz. We arranged the results in a comprehensive excel sheet, making it easy to manipulate for analysis and interpretation.

Based on our preliminary test group, we were able to assess the effectiveness of our game at teaching pointers. The results, as we'd hoped, show the game was indeed helpful in teaching pointers to students.

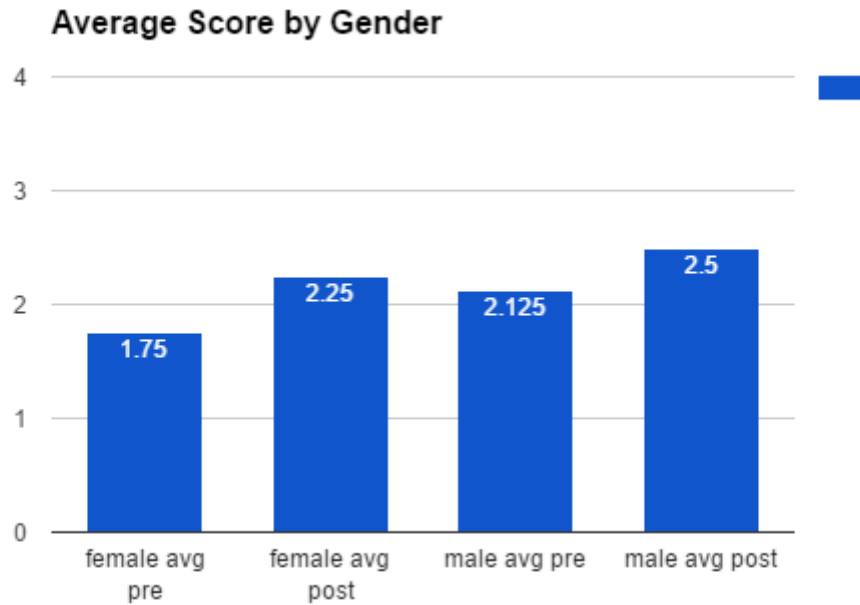


Figure 4.0 Average Score by Gender

We also found that it was slightly more helpful for the female students when we compared the differences in the pre and post survey scores (figure 4.0) However, this fact is likely negligible considering the small sample size of players.

### V) Future Work

Now that we have working versions of our positive vs negative feedback games we will work on testing the their roles in helping or hindering the students ability/desire to learn these programming topics.

Once we have finished testing our game on a large set of players at our respective colleges, we will review the data collected. Based on the surveys, we should get a general idea of how helpful the game was in helping students learn the concepts.

We also incorporated google analytics into the game. This allows us to track the user experience in more detail, getting results not just from the surveys, but by tracking the player's process. Google analytics lets us gather data on things such as how long a level took or how many times a player answered a question wrong. process. We expect this will give us a better understanding of what works in game-based computer science education.



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## VI) Web Links

Claudia's blog: <https://codevation.wordpress.com/>

Florencia's blog: [flosalinas-creu.com](https://flosalinas-creu.com)

Chava's blog: <https://cshulmancreu.wordpress.com/>

Download the game:

[https://www.dropbox.com/sh/m7o9f1peamb23i7/AABdFJxW0w40Db1L\\_1TxJTp7a?dl=0](https://www.dropbox.com/sh/m7o9f1peamb23i7/AABdFJxW0w40Db1L_1TxJTp7a?dl=0)

## VII) Presentations and Publications

Title: *A Serious Game to Teach Computing.*

Presentation: Poster

Venue: Science Day, Brooklyn College

Date: May 5, 2017