LESSON STUDY IN COMPUTER SCIENCE: INHERITANCE

PART 1: OVERVIEW

Lesson Title: Discovering Inheritance through a Popular Video Game in CS1

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Discipline or Field: Computer Science

1 APPROACH

In order to quantify the difference between the new lesson and the older lesson we attempted to create a control group. The same professor taught three sections of Computer Science 1 during the fall semester. One of the sections completed the well established inheritance lesson based on bank accounts. The two other sections completed the newly created Mario lesson. The three sections were presented the same course materials except for this lesson during the semester. In fact, we did not decide which section would be the control section until the week before the laboratory. We wanted to make sure that the sections were performing similarly on the preceding exams and laboratories. We treated all three laboratories the same. The students completing the older lesson were video taped and given the surveys in the same manner that the new lesson was observed. Aside from signing the waiver to gather data, the students did not know that anything was different and they did not know that different sections would complete different laboratories.

2 FINDINGS

Two video cameras captured student responses during the lesson. Exit interviews were completed with two separate pairs of programmers. Important observations are available for review on the web [7]. In addition, the students completed a survey shown in Appendix D with results showing an increase in engagement in the new lesson compared to the established lesson. A quiz was administered four days after the laboratory session on inheritance. The students completing the new lab performed slightly better on the quiz than those that completed the older lesson. The details of the findings are explained in the next few sections.

2.1 Exit Interviews

Two teams of pair programmers were interviewed on video [7] after the completion of the laboratory project. Each team consisted of one male and one female.

2.1.1 Team1

They stated that it was the most fun that they have had in a lab through the opportunity to interact with a graphics environment. The team was more engaged in the programming as it was “not boring”. The female team member suggested that this lesson really helped her understand the “tree” and how to “pass in and override” to make the code “shorter”.

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2.1.2 Team2
This team expressed the same enthusiasm about the engagement of the project. The female felt “confident and understood what we were doing today” after expressing frustrations in understanding earlier course material. In response to what she learned she claimed to “understand the tree.” In a telling remark she expressed that the ability to “see what is actually going on is what I really enjoyed.”

Her partner explained that he was familiar the objects and the game scenario as he had the background of playing video games. He would like to dig into the program some more and believed it would be fulfilling to complete a series of projects based on elements of this game.

2.2 Student Engagement Survey Results
At the end of each laboratory throughout the semester, students complete a set of questions regarding the lab before receiving credit for the lab. The students receive a single participation grade for completing the laboratory and set of questions. The survey shown in the appendix with the following questions was administered at the conclusion of the lesson in the place of the usual questions. The older lesson was based on the well known bank accounts hierarchy and is widely used and well established in computer science as a successful lesson.

2.2.1 Survey Results

<table>
<thead>
<tr>
<th>Number of Students</th>
<th>Lesson</th>
<th>Question Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>23</td>
<td>Older Bank Account Lesson</td>
<td>2.74</td>
</tr>
<tr>
<td>46</td>
<td>Mario Lesson</td>
<td>3.28</td>
</tr>
<tr>
<td>Increase in new lesson</td>
<td></td>
<td>19.8%</td>
</tr>
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</table>

Table 1. Survey Results comparing the new Mario Lesson the older bank account lesson.

2.2.2 Survey Questions- Results and Discussion

1. How much did today’s lab exercise increase your understanding of the inheritance hierarchy in an object oriented program? (1-No help, 2-Somewhat helpful, 3-Helpful, and 4-Extremely helpful)
   New lesson moved above the helpful range with an average of 3.28 compared to 2.74 for the older approach. The opportunity to visually observe the sprites objects and creating the hierarchy as a group targeted this improvement.

2. How much did today’s lab exercise help you understand the power of inheritance in Java (i.e., based classes and derived classes)? (1-No help, 2-Somewhat helpful, 3-Helpful, and 4-Extremely helpful)
The new lesson again moved above the helpful range with an average of 3.33 compared to 2.70 for the older approach. The opportunity to visually observe the sprites objects and creating the hierarchy as a group targeted this improvement. In addition, the students had the opportunity to add functionality to a complex set of code with minimal effort through code reuse in inheritance.

3. **How well did today’s lab exercise help you to understand the process of overloading and overriding base class methods? (1-No help, 2-Somewhat helpful, 3-Helpful, and 4-Extremely helpful)**

The new lesson showed only comparable results to the older lesson. The new lesson could use more emphasis on overloading and overriding methods. The older lesson is strong in this area.

4. **How interesting was the application used for today’s lab exercise? (1-Boring, 2-Marginally interesting, 3-Interesting, and 4-Exciting)**

This is the area where the new lesson was targeting an increase. We believed that a familiar video game would increase the interest in the subject. The new lesson scored close to the top level of exciting with a 52% increase in student excitement results. In fact the older lesson showed its lowest score in this area, while the new lesson showed its highest score. The opportunity to play a familiar game for learning a computer science subject proved exciting to the students. In addition, the opportunity for students to complete the functionality in a familiar game was observed to be motivating and reinforced through exit interviews.

5. **How would you rate this lab exercise overall? 1-Not useful, 2-Somewhat useful, 3-Useful, and 4-Extremely useful)**

While the well written and established older lesson was seen as useful for the students, the new lesson was seen as extremely useful by half of the students.

2.3 **Quiz Results**

The overall scores for the lesson show that the new lesson is as successful as the well established bank accounts approach for teaching inheritance. The older lesson was based on the well known bank accounts hierarchy and is widely used and well established in computer science as a successful lesson. The new approach showed a slight increase of 3% over the accounts lesson.

<table>
<thead>
<tr>
<th>Students</th>
<th>Lesson</th>
<th>Quiz Average</th>
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</thead>
<tbody>
<tr>
<td>23</td>
<td>Older Bank Account Lesson</td>
<td>7.476</td>
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<tr>
<td>46</td>
<td>New Mario Lesson</td>
<td>7.698</td>
</tr>
</tbody>
</table>

Table 1. Quiz Results for students that completed the two lessons.

2.4 **Additional Observations**

The entire lesson is observed by all members of the Lesson Study team. Many of these significant observations captured on videotape are available online[7].

2.4.1 **High Level of Engagement**

Observations of the students showed them clearly engaged in the game and identifying the objects for missing functionality. They expressed a sense of accomplishment in extending the functionality of the game.
2.4.2 Sense of Accomplishment
Two different groups shouted “Yes!” when their new code provided the expected functionality of the game. In our 60 years of experience in teaching labs on inheritance, none of the observing professors remembers this happening. The graphical demonstration of their results was valued by the students.

2.4.3 Exploring beyond the Assigned Project
From the back of the room it was observed that students would “sneak” some time to complete other tasks during the class. Students were observed investigating how the images could look like Mario is running on the screen. Other students were noted to explore code to try to further understand how the program worked. It is encouraging that students showed enough engagement to further investigate the program.

2.5 DISCUSSION
Using a familiar video game allowed student to easily identify the object in a large amount of code. The familiar game engaged the students quickly into the project by completing the tasks in about half the expected time for the project. Students were motivated to add functionality that they expected to be in the game allowing the illustration of the value of code reuse in inheritance. The students working on the project expressed fulfillment and increased understanding through the visual feedback provided by a graphical environment. The survey and quiz provide quantitative results showing that students met the objectives of better understanding inheritance. It is hoped that the increased usefulness and interest in the project expressed by the students, results in a deeper appreciation and understanding of the value of inheritance in object oriented programming. Student engagement in the new laboratory ranked close to exciting versus a ranking of marginally interesting to interesting for the older lesson. In addition student surveys show that students believe that the lesson increased their understanding of inheritance hierarchies, the power of inheritance, and the usefulness of the lab compared the students completing the older lab.

2.6 FUTURE WORK
This code provides a foundation for building new games with different (non-copyrighted) materials. This would support the development of additional projects on this somewhat familiar code. Follow up lessons on polymorphism, interfaces, and abstract classes based on this code would further reinforce the value of object oriented code. In addition, a group of students are currently developing a generic side scrolling game engine based on this code. This would allow the development of a project for students to build their own object-oriented games based on their knowledge acquired through this lesson.

2.7 ACKNOWLEDGMENTS
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REFERENCES


