7-16-2016

Practice and Refactoring Log: A Reflection Based Learning Strategy to Improve the Fluency of Computing Students in Writing Computer Programs

Elizabeth Dancy
Sheridan College, elizabeth.dancy@sheridancollege.ca

El Sayed Mahmoud
Sheridan College, elsayed.mahmoud@sheridancollege.ca

PRACTICE AND REFACTORING LOG: A REFLECTION BASED LEARNING STRATEGY TO IMPROVE THE FLUENCY OF COMPUTING STUDENTS IN WRITING COMPUTER PROGRAMS

Dancy[1], Elizabeth; Mahmoud[2], El Sayed

[1 & 2]*Faculty of Applied Science and Technology, Sheridan College, Canada*

Abstract

The relationship between reflection and learning is evident. Reflection plays a significant role in learning by encouraging insight and complex learning. However, most students consider their work experiences at school as isolated and unrelated events. This work aims to investigate how to improve the students' fluency in writing computer programs through reflection. A new deliverable, the Practice and Refactoring Log ("PAR Log"), is requested for each assignment in order to engage students in the process of making meaning from their experiences when completing their assignments. The PAR Log shows and justifies all changes through the assignment development cycle. Two student groups were required to develop and submit the PAR Log with all assignments, for credit. The performance of each group was compared to a similar group taught the same course by the same professor using the same assignments but without requesting the PAR Log. This paper presents the background, methodology, results, analysis and conclusion of this investigation.

Introduction

This study was motivated by our collective experiences in the classroom and the observation that many computer science students were not able to explain their work. It is commonly accepted in mathematics that showing your work is equally as important as arriving at the correct solution, yet in computer science we grade solely on the final version (and some planning or modelling). In addition, we noticed our students tend to think of their assignments as isolated events. Based on our understanding of the value of reflection in promoting insight and complex learning, we wondered, if we required our students to show their work by providing a PAR Log, would the students' coding fluency increase?

Methodology

In the **winter term of 2016**, we chose two programming classes to study. The first is Java programming, level 1 and the second is C programming, level 4. The students in these classes were asked to submit a PAR Log with every assignment. The PAR Log was **worth 15%** of the overall assignment grade. The PAR Log was meant to show each revision a student undertook to approach their final program as well as any outside practice such as attending a tutoring session, watching an online video or attending office hours. The PAR Log was presented to the students as follows: The "refactoring" portion of the PAR Log satisfied the "show your work" requirement and the "practice" portion of the PAR Log supported the goals of reflection and connection.

Results

Both classes were compared with a **control group** of students taught the same course by the same instructor with the same assignments, in a previous semester. The students in the C programming course showed no statistically significant improvement in grades over the term yet the students in the Java programming course did show a **significant improvement in grades** (see Figures 1, 2, and 3). The two

groups showed a significant **improvement in the professors' rating of student comprehension** and ability to explain their work, likely brought on by the additional reflection and/or practice involved.
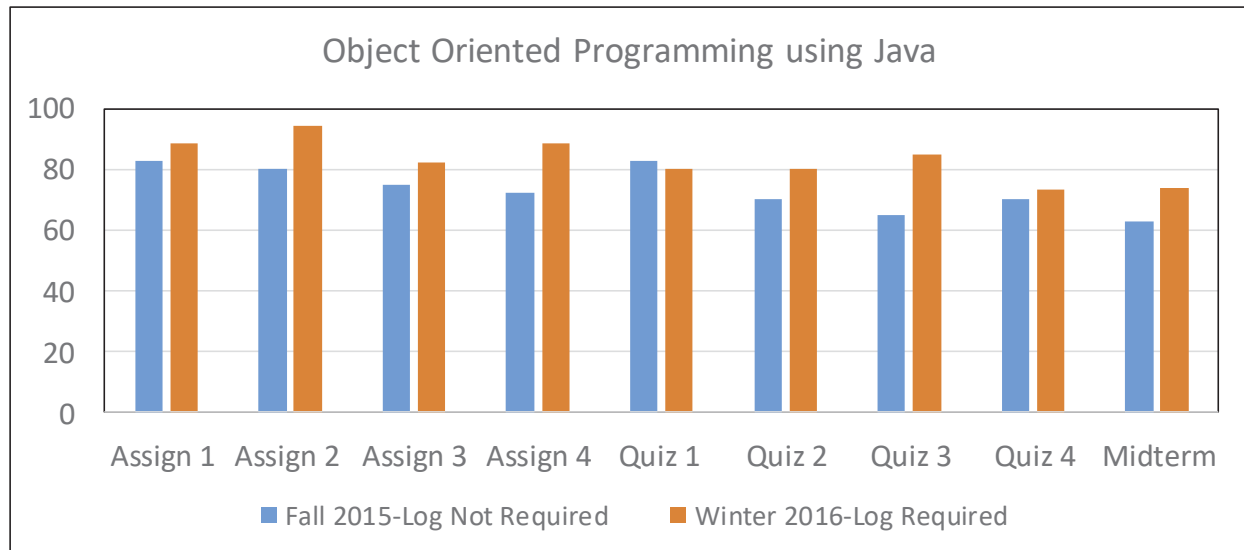

Figure 1: Median grades for assignments, quizzes, and midterm exam calculated to compare the performance of two Java programming classes. The first class was offered in the Fall 2015 term when the PAR Log was not required. The second was offered in the Winter 2016 term when the PAR Log was required.
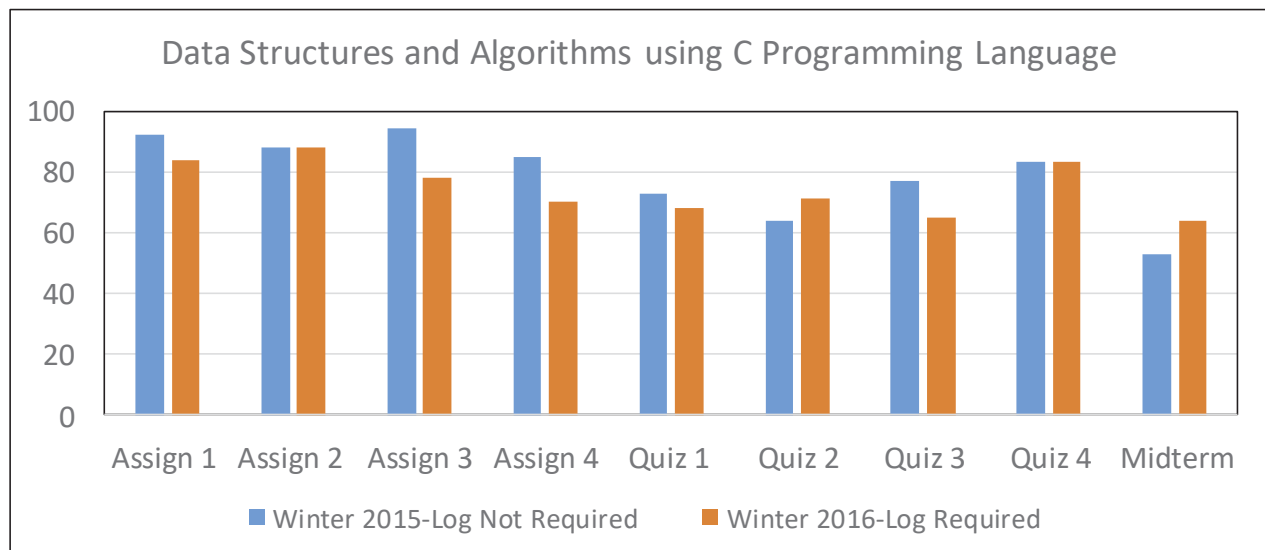

Figure 2: Median grades for assignments, quizzes, and midterm exam calculated to compare the performance of two C programming classes. The first class was offered in the Winter 2015 term when the

PAR Log was not required. The second was offered in the Winter 2016 term when the PAR Log was required.

Discussion

The Java class's grades on assignments, quizzes and the midterm exam significantly increased by 9.4% (using median values) compared to the grades of the Java group that was not required to submit the PAR Log (see Figures 1 and 3). This was probably an effect of the reflection practiced by the students to develop the PAR Log properly, as reflection encourages insight and complex learning (Costa, A. & Kallick, B., 2008), (Kolb, D., 1984).
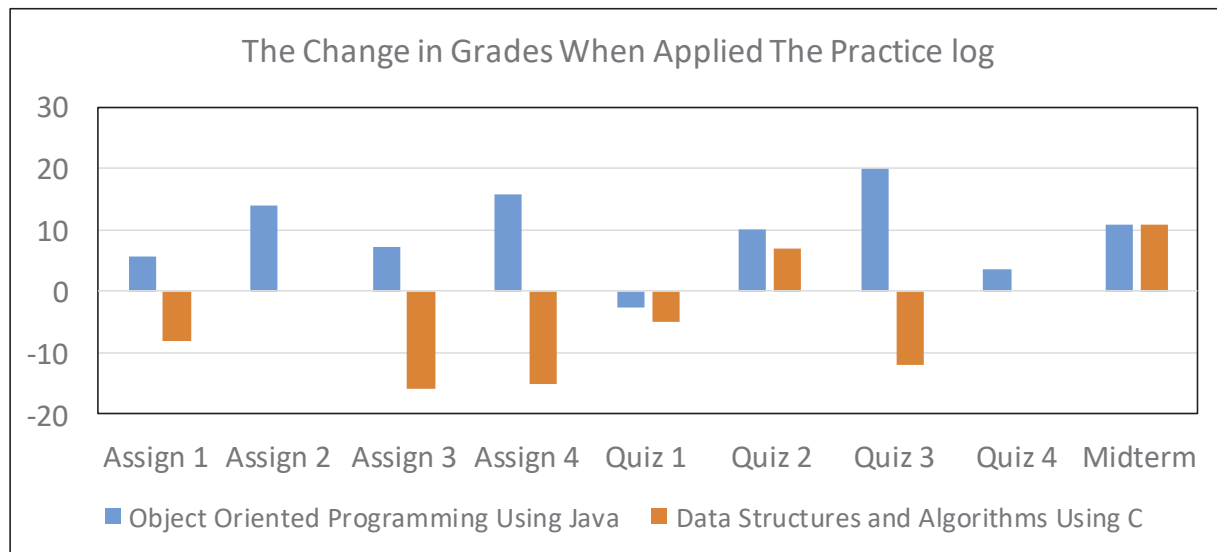

Figure 3: The difference between the grades' medians before and after using the PAR Log for engaging students in reflection in the Java programming and the C programming classes.

On the other side, the change in the C class's grades of assignments, quizzes and midterm exam was not significant (see Figures 2 and 3) compared to the grades of the C class that was not required to submit the PAR Log. This may be explained by the variation in the course levels, as the C course is taught to the fourth term students but the Java course is taught to the first term students. This may indicate that the learning habits of the fourth term students are not as easy to change compared to those of the first term students. The first term students expect and accept changes in learning methods because it is their first experience in post-secondary education. Reflection skill has proven to be relatively challenging to develop (Gustafson, K. and Bennett, W. ,1999).

The improvement in the reasoning ability of the Java students is demonstrated by the increased grades in the quizzes and the midterm exam. The quizzes and midterm exam grades of the Java class significantly increased by 8.4% on average (again using medians) compared to the grades of the corresponding class that was not required to submit the PAR Log (see Figures 1and 3). This improvement could be attributed to the PAR Log since it forces practice in reasoning which is the backbone of the quizzes and the midterm exam.

The C class's median of the midterm exam grades increased by 11% compared to the grades of the corresponding class that was not required to submit the PAR Log (see Figures 2 and 3). This was probably a late response to the consecutive teaching moments that encouraged students to change their learning habits and practice reflection. The relative improvement in the grades of assignment 4 supports this late response explanation too because assignment 4 is the most challenging assignment in the course.

Conclusions

This work investigated a new strategy that improves a student's fluency in writing computer programs through reflection. The strategy employed was to request a deliverable, the Practice and Refactoring Log, to be developed and submitted with each assignment. The PAR Log shows and justifies all changes throughout the assignment development cycle. Developing this PAR Log engages students in the process of making meaning from their experiences when completing their assignments. Two student groups were asked to develop and submit the PAR Log with all assignments, for credit. The first group was an introductory Java course and the second group was an advanced C programming course. The performance of each group has been compared to a similar group taught the same course by the same professors but without requesting the PAR Log. The results show an improvement in the students' ability to describe and justify programming design selections across both groups. The grades of the assignments and quizzes of the Java group are significantly improved but the grades of the C programming group are not improved. Thus we conclude that using the PAR Log in the first semester is more effective at increasing programming fluency because new students are more receptive to building and changing their learning habits at the beginning of their post-secondary program.

References

Costa, A.L. & Kallick, B. 2008. *Learning and Leading with Habits of Mind: 16 Essential Characteristics for Success.* Association for Supervision & Curriculum Development

Gustafson, K., & Bennett, W. 1999. Issues and difficulties in promoting learner reflection: Results from a three-year study.

Kolb, D. 1984. Experiential learning: Experience as the source of learning and development. Englewood Cliffs, NJ: Prentice-Hall.