

AC 2009-1487: ON-LINE EXAMINATIONS FOR OBJECT-ORIENTED PROGRAMMING

Cordelia Brown, Purdue University

Yung-Hsiang Lu, Purdue University

Melissa Yale, Purdue University

Deborah Bennett, Purdue University

On-Line Examinations for Object-Oriented Programming

Abstract

On-line content (such as handouts) have been widely adopted in today's classrooms. On-line examinations have yet to be accepted due to several reasons. For example, computers and networks may be unavailable during an examination; email and instant messaging may compromise academic honesty. This paper reports our experience in using on-line examinations for a course on object oriented programming. It has been observed that traditional paper examinations do not necessarily reflect students' programming skills. We study whether on-line examinations are more appropriate for a programming course. The examinations can be taken on-line or on paper in a classroom. Both formats are open-book and open-note and have the same amount of time. This study considers the following questions: (1) Do students perform better in on-line examinations because they can type, instead of writing, code and have access to compilers? (2) Do students prefer on-line examinations to traditional paper-based examinations? What are the reasons? (3) How can appropriate technology be used to maintain honesty? We measured the appropriateness of on-line examinations through comparing the performance of students taking the exam on-line to those taking the paper version of the exam. We also measured the appropriateness through surveys and focus groups with the students and the instructors.

Introduction

This study involved students in an elective senior-level “Object-Oriented Programming using C++ and Java” course at Purdue University¹. In this class, the students learned the concepts of object-oriented design and programming, including: (1) class and objects, (2) inheritance and polymorphism, (3) function overriding in derived classes, (4) operator overloading in C++, (5) exception handling, (6) container classes, (7) multiple inheritance in C++, (8) graphical user interface using Netbeans and Qt, (9) client-server networking, and (10) multithreading. The textbook is “Programming with Objects: A Comparative Presentation of Object-Oriented Programming with C++ and Java” by Avinash C. Kak published by Wiley². All lectures were recorded in advance using Camtasia Studio. This tool performed screen capture with narration so that the instructor could show slides, websites, code, and demonstrations of program execution.

The course included five programming assignments, ten laboratory exercises, four exams, and a final exam. There were three lecture sessions (50 minutes per session) scheduled per week. The lectures were recorded on video. Students were encouraged to view the lecture according to a schedule for the course materials. There were two lecture videos per week. The instructors were available in the software laboratory during the lecture hours, three times a week. Students could use the lecture hours for programming assignments, lab exercises, discussion, or asking questions. Additional office hours could be arranged by email.

The lectures, assignments, and lab exercises were recorded in separate videos. Questions were embedded in the lectures as self tests. The lab exercises were closely integrated with the programming assignments. There were practice questions at the end of each video clip. The source code used in each lecture was available separately so students can study the source code.

Methodology

For this study, four 50-minute exams were administered during the class period. The first two exams were offered as a paper version only. For the third exam, students had an option of taking the exam on paper or on-line. On the third exam, students were asked the same 16 questions in both formats. On the paper version of the third exam, students took the exam during the 50 minute class session in the classroom. The exam was open-book and open-notes. Electronic devices were not allowed. The on-line exam version of the third exam was given through the courseware tool, Blackboard™. Students were given 55 minutes to take the exam. Five additional minutes were given for students to familiarize themselves with the exam format. The on-line exam could have been taken in the software laboratory or in the classroom if the student brought his/her own laptop. Students were allowed to type the program, compile, and execute it. Compilers could be used by students taking the on-line format of the exam. Collaboration was not allowed in either format. No other on-line resources were permitted.

There were 36 exams taken on-line. The third exam and the final exam were offered in two formats: paper and on-line. Twenty students took the third exam on-line, and sixteen students took the final exam on-line. Of those on-line exam takers, nine students took both the third exam and the final exam on-line. Eleven students took the third exam on-line, but not the on-line final exam. Seven students took the final exam on-line, but not the on-line version of third exam. The final exam was two hour long and contained more coding questions. Since students were allowed to copy code from lectures and their assignments, on-line exam had the advantage.

Analysis

Along with assessing the performance of students taking on line exams versus performance on paper exams, an electronic survey was distributed to students in order to assess students' opinions about the advantages and disadvantages of the two exam formats^{3,4,5,6}. The sample size was relatively small, $n = 46$.

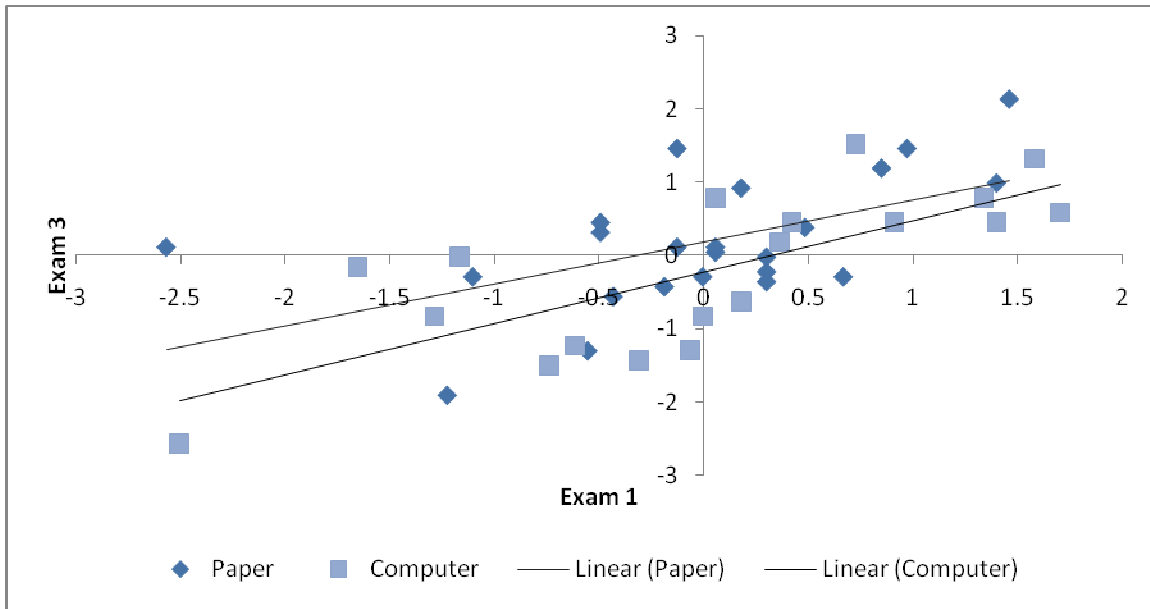


Figure 1. Correlation of Exam Scores of Exam 1 to Exam 3 of Paper and Computer Exam Takers

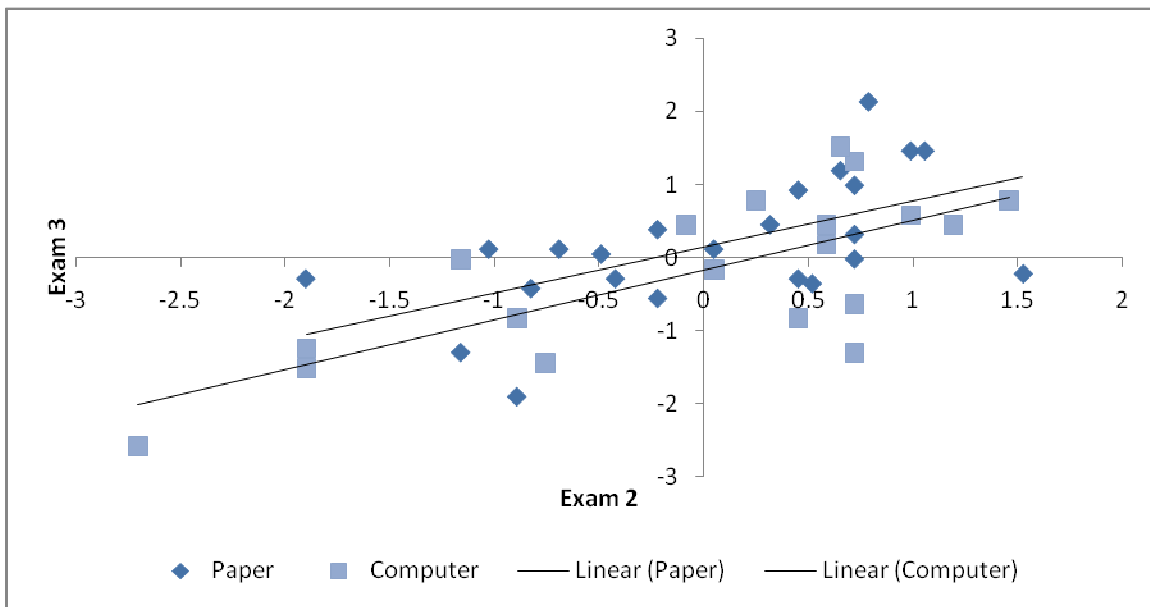


Figure 2. Correlation of Exam Scores of Exam 2 to Exam 3 of Paper and Computer Exam Takers

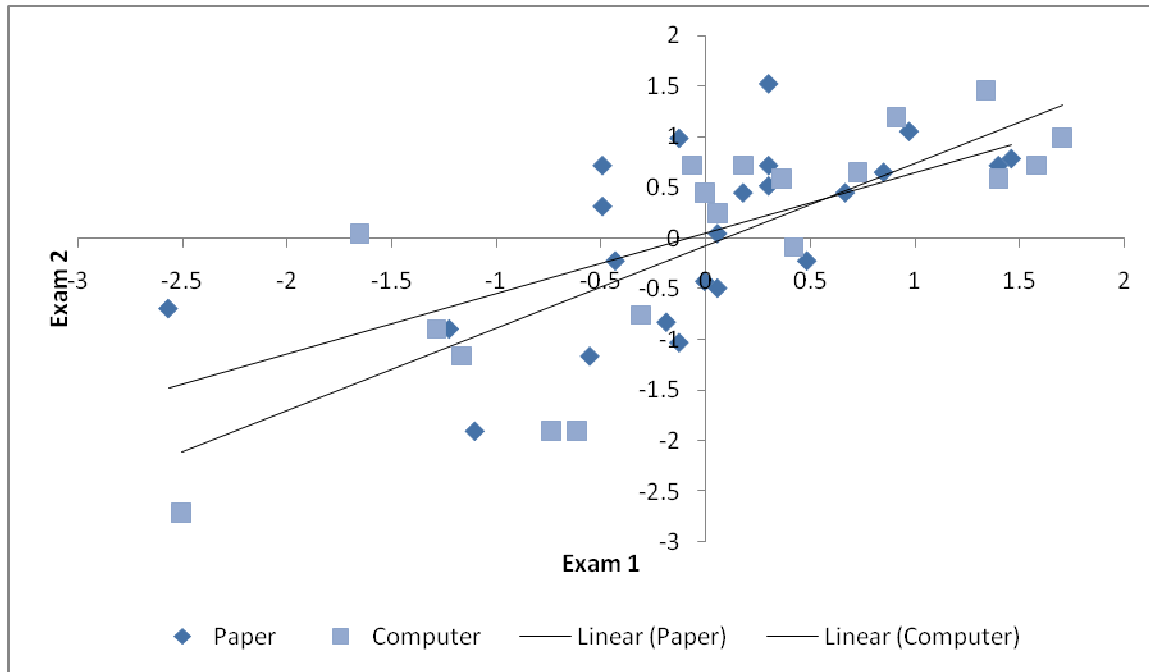


Figure 3. Correlation of Exam Scores of Exam 1 to Exam 2 of Paper and Computer Exam Takers

The average of the third exam on paper is 59.9, on line was 54.2. The standard deviation was 14.9 so the difference is only 38% $(59.9-54.2)/14.9$. The median of the paper group was 59 and the on-line group was 57. These numbers suggested that on-line and on-paper exams have no noticeable difference.

The class was divided into two groups based on their third exam format: “on paper group” and “on-line group”. The average of the second exam in the "on paper group" was 72. The average of the second exam in the "on-line group" was 70.5. An explanation for this finding may have been that students preferred to take the paper exam because they had been doing well and did not want to take the risk of an on-line exam. However, the difference $(72-70.5)$ was also small and insignificant.

The average of the first exam in the "on paper group" was 62.9. The average of the first exam in the "on-line group" was 63.4. The standard deviation of the exam was 16.4. The difference $(63.4-62.9)$ was too small to be meaningful.

During the analysis, a question about predictability arose. For each student, is the first exam or the second exam a good predictor of results on the third exam? To do this analysis, the students' score in each exam was normalized relative to the mean and the standard deviation, i.e. $(\text{raw score} - \text{mean}) / \text{std.}$

The correlation between the first exam and the third exam in the paper group was 0.56 (Figure 1).

The correlation in the on-line group was much higher 0.74. This was also true for the other pairs of exams. The correlation between the second exam and the third exam was 0.59 for the paper group and 0.73 for the on-line group (Figure 2). The correlation between the first exam and the second exam was 0.61 for the paper group and 0.80 for the on-line group (Figure 3). The data suggested that students in the on-line group were more consistent in exam performance than students in the paper group. The on-line exam does not make students perform much better or worse. Overall, the difference between paper and on-line is not significant. Another interpretation was that the exam was fair to the two groups.

Survey Results

Students were administered an electronic survey through Blackboard™ assess their opinions about various aspects of the instruction and assessment of the course. The electronic survey consisted of choice response questions and open response questions. For the document, results pertaining to on-line exams are reported.

Question	% of respondents
Did you take the third exam on-line?	
<i>True</i>	42.3%
<i>False</i>	57.7%
Do you think on-line exams are better in a programming class because you can type, not write, code?	
<i>Yes. I can answer the questions much faster.</i>	12%
<i>Yes, but the advantage is not significant.</i>	40%
<i>There is no difference.</i>	28%
<i>No, I feel taking an on-line exam is more difficult.</i>	12%
<i>No, there are too many (technical) problems (such as slow network and power failure) with an on-line exam. Paper exams are much better.</i>	8%
Do you think cheating is easier for on-line exams since the instructor is not watching?	
<i>No. There is no difference. I don't cheat and my classmates do not cheat, either.</i>	20%
<i>No. There is no time to cheat.</i>	28%
<i>Yes, but only slightly. It is easier to call someone to help. Two students could sit together and discuss the answers.</i>	40%
<i>Yes, it is a serious problem. Cheating is so easy for on-line exams.</i>	12%

Figure 4. Survey results of choice response questions

Along with choice response questions, students were also asked open response questions. The open response questions about exams were as follows:

Can you explain why you took the third exam on-line or on paper? Please list all reasons you have.

There were four general categories that student responses were grouped into for reasons for taking the on-line exam: (1) No difference between the on-line or paper version of exam; (2) Availability of on-line resources; (3) Ability to compile code; and (4) Willing to try something new.

There were three general categories that student responses were grouped into for reasons to take the exam on paper: (1) Comfort with paper test; (2) Potential technical problem with on line exam; and (3) No opportunity to practice on-line format.

While developing this study around on-line exam, we were mindful of various issues surrounding honesty on exams.

Honesty on paper exams

What can be done (and should be done) to prevent cheating in paper exams?

The responses are grouped into four general categories: (1) seating arrangements; (2) randomizing exam questions; (3) having open response questions; and (4) course staff monitoring students.

What can be done (and should be done) to prevent cheating on on-line exams?

The categories of the responses are as follows: (1) restrict on-line person to person communication options (i.e. Instant Messaging, email, etc.); (2) course staff should monitor computer screens; and (3) special limited access computer accounts.

Observations and Conclusions

On the technical side of on-line exams:

1. Blackboard™ assessment will eliminate the format in students' answers. Even though a student submits a properly indented program, Blackboard™ will remove newlines and the code is very hard to read. For future on-line exams, we should create an assignment (not assessment) and ask students to submit code as attachment.
2. If a question contains a hyperlink, the link should open a new window. Otherwise, when a student clicks this link, Blackboard™ will visit the link and the previously filled answers are lost.
3. Blackboard™ does not allow submitting HTML code in an assessment. This was a problem since students were asked to write an Applet and an HTML file to use the Applet.
4. The Blackboard™ assessment feature only allows 50 lines of code. Each question had to be limited to at most 50 lines. This may be insufficient for a long program.

A simple solution is to ask students to submit file attachments through the assignment feature, not the assessment feature. The Blackboard™ assessment feature does not allow attachments.

The preliminary conclusions suggest that there is no significant difference in performance between the paper and on-line exams. We can also conclude that the paper and on-line exam did not put either group at a disadvantage. Through the electronic survey, we were able to find out that 80% of the respondents relayed that there was no difference, slight advantage, or it was better to use the on-line format of the exam. There was almost an even split on whether it was easier to cheat with an on-line format. The researchers of this study intend to continue to collect more data on the use of on-line exams in computing courses.

Acknowledgements

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