



The Role of Automation in Undergraduate Computer Science Education

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Published in:



• Proceeding
[SIGCSE '15](#) Proceedings of the 46th ACM Technical Symposium on
Computer Science Education
Pages 90-95
[ACM](#) New York, NY, USA ©2015
[table of contents](#) ISBN: 978-1-4503-2966-8 doi> [10.1145/2676723.2677226](#)



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September 15, 2020 (CSC 450-02)

<http://dl.acm.org/citation.cfm?id=2677226>

Article: The Role of Automation in Undergraduate Computer Science

- Background:
 - Grading is a very time-consuming element of teaching
 - Automated grading has advantages
 - Students can submit programs online where they are automatically graded
 - Students receive relatively fast feedback
 - Students can submit multiple times, can make corrections and better learn the material
- Objective: Look at effect of automatic grading (+peer instruction) on learning and other outcomes

CS1 Checkin

https://www

Foundations in Programming

Home Syllabus Policies Progress Tutorials Programs Resources Checkin

SERVER TIME

P3: Tax Computation OPEN

P2: Numbers and Strings OPEN

P1: Let's Get Started! CLOSE

Posted Date: Sunday, 08-03-2014 @ 08:00

Due Date: Sunday, 08-17-2014 @ 12:00

Late Deadline: Sunday, 08-17-2014 @ 22:00

Current submission: Friday, 08-15-2014 @ 09:17

Submission Status: Present REVIEW

BROWSE... No file selected. SUBMIT

Preliminary Testing: 3 / 7 DETAILS

Final Grade: Not Graded DETAILS

Figure 3: Automated Program Grading Interface.

Classes, Methods, Data

What does the following code print?

```
public class Peer {
    static int i = 12;
    int j = 23;
    public static void main(...) {
        Peer p1 = new Peer();
        Peer p2 = new Peer();
        p1.i++; p1.j = 34; p2.i++; p2.j = 45;
        System.out.println(p1.i + " " + p1.j + " " + p2.i + " " + p2.j);
    }
}
```

A. 13 34 14 45
B. 13 45 14 45
C. 14 34 14 45
D. 14 45 14 45
E. Will not compile

CS 160, Spring Semester 2014



Semester	Zeros Included	Mean	Median	Sample Size	Stddev	Variance	Increase	Statistical Significance
Spring 2013	Yes	66.1	71.0	234	20.3	410.4	+0.0%	base semester
Spring 2013	No	68.5	71.0	234	16.2	264.0	+0.0%	base semester
Fall 2013	Yes	70.3	76.3	252	24.1	582.7	+6.4%	t = 2.07 p = 0.0388
Fall 2013	No	75.7	79.0	252	14.7	216.3	+10.6%	t = 5.04 p < 0.0001
Spring 2014	Yes	73.9	78.0	232	20.5	422.3	+11.8%	t = 4.11 p < 0.0001
Spring 2014	No	77.6	78.0	232	12.5	156.8	+13.3%	t = 6.63 p < 0.0001

Figure 5: Analysis of Exam Scores.

Conclusions

- The combined adoption of new pedagogic techniques (automated grading + peer instruction)
 - improves the average final exam scores and overall grade.
 - decreases the student withdrawal rate.
 - improves student attendance.
- Limitations
 - Automated grading and peer instruction are confounded
 - Are students just better over time (uncontrolled extraneous variable)?
- Additional observations
 - Automated grading has an unforgiving nature
 - Some students throw submissions at automated grading

Project idea: development of an automated tool for learning *R* programming

R programming and swirl

- R (<http://www.r-project.org>) is a free environment for statistical computing and graphics
- R is an interpreted language
- Many *packages* are available for specialized analyses (<http://cran.r-project.org/web/packages/>)
- Swirl (<http://swirlstats.com>) is a package where you can "learn R, in R."
 - Questions are hard-coded
 - This makes *swirl* appropriate for learning but not for practice and/or assessment

Proposed project

- Develop a swirl-based package that generates template-based problems to help students practice *R* programming and data analysis concepts
- Question templates that use random variable names and/or values:
 - Question: Create a vector named 'x' that stores the values 3 and 11.
 - Solution: `x <- c(3,11)`
- Improvement: values in red above are randomly generated each time.

Questions:

1. What is the best way to learn a new programming language?
2. What programming exercises will best help you learn the concepts?
3. What is the best way to assess someone's programming ability?
4. Does anyone have experience creating R packages (how do you do this)?
5. Does anyone know how to generate random numbers in *R*?