Many Small Programs in CS1: Usage Analysis from Multiple Universities

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Research outset: Spring 2017

Our goal: Improve the student experience in CS1
  • Improve satisfaction & happiness
  • Without worsening performance

Our focus: Weekly programming assignments
  • Large part of the students’ experience
  • Key source of issues – student struggle/fear
Traditional: One Large Program (OLP) each week

- Solution 50-200 lines
- Long spec
Many Small Programs (MSPs) each week

Our approach: 5-7 MSPs
- Solution 10-50 lines each
- Short & concise spec

Benefits
- Less intimidating
- Pivot if stuck
- Build confidence, more practice

Enabled by new auto-graders
- Easy to create / Instant feedback
- zyLabs (zyBooks): ~30 min create lab
3.15 CH3 LAB: School type (branches)

Write a program that takes an integer as input, representing a year in school. Output "Elementary school" for 0-3, "Middle school" for 4-8, "High school" for 9-12, "College" for 13-16, and "Post-secondary" for 17 and higher. Output "Invalid" for negative input. If the input is 7, the output is:

```
Middle school
```

1. Compare output (2 points)
- When input is 7
- Standard output exactly matches: Middle school

2. Compare output (1 point)
- When input is -1
- Standard output exactly matches: Invalid

Specification
Template Code
Assessment
MSP walkthrough
Previous work: MSP impact on student satisfaction

Controlled study, Spring 2017 UCR's CS1
- 1 MSP section (76 students), 2 OLP sections (166 students)
- 7 MSPs/week, 70 pts total, 50 pts full credit

![Survey Results Graph]

- Higher is better
- Lower is better

- I enjoy the class
- I felt prepared for the midterm
- I enjoyed the programs
- I learned a lot from the programs
- I am confident in my ability to program
- I'm anxious about the class
- I feel anxious about the final
Previous work: MSP impact on student learning

As a result, all CS1 courses at our university switched to using MSPs, including dozens of other schools.
Previous work: MSP usage analysis - UCR

Asked a variety of research questions
- Time spent per week?
- When do students start working?
- Etc.

Conclusion: students make good use of MSPs
- Sufficient time
- Started early
- Completed more than necessary
- Pivoted to help selves when stuck
- Used MSPs to study for exams
- MSP CS1 students do just as well as OLP CS1 students in an OLP CS2
# MSP usage analysis - Other universities

<table>
<thead>
<tr>
<th>Prog Language</th>
<th>#Students</th>
<th># MSPs</th>
<th># Submissions collected</th>
<th># Develops collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>University 1</td>
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</table>
Data collection

10 universities, 1,179 students included
• All data anonymized – university name, details, and student information

Multiple programming languages
• C++, Python, Java

Used zyLabs from zyBooks (MSPs)

Collected:
• 302,406 develops & 192,657 submissions
Q: How much time do students spend working on each MSP?
A: At least 12 min / MSP

UCR average time spent per MSP - 17 min / MSP
Q: How many days before the due date do students start working on MSPs?
A: MSPs started 2.2 days before due date

UCR average days before due - 2.7 days
Q: What score do students earn per MSP?
A: Students score an average of 91% per MSPs

UCR score per MSP – 89%
Conclusion

Similar results across all other universities
- Spend sufficient time
- Start early
- Complete most MSPs

MSP usage growing
- All CS1’s at UCR
- Dozens of other universities

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