An Analysis of Using Many Small Programs in CS1

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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
Previous: MSP impact on confidence/stress?

- 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

Higher is better

Lower is better

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Dozens of schools have switched to MSPs, many using UCR's MSPs (orig C++, now Java, Python, and C), reporting good results.
This paper: Answer common questions about MSP use

- Time spent per week?
- Time spent per MSP?
- When do students start on MSPs?
- What % completed each day?
- Given full-credit threshold, do students complete more?
- Do students pivot, or switch among MSPs when stuck?
- Are MSPs used to study for exams?
- Won't MSP CS1 students do poorly in an OLP CS2?

"Fact-finding mission"
Data

- UCR CS1 Spring 2017 MSP section: 76 students
- Used zyLabs from zyBooks
- Collected:
  - 48,000 develop runs
  - 16,000 submissions
  - Each has labID, userID, score, maxScore, time/date,
Q: How much time do students spend working on MSPs each week?
A: At least 120 min / week

NOTE: Underestimate. Students with 0 subs or 0 time excluded. Avg is for weeks 2-8.
A: About 17 min per MSP

Average time spent per MSP - 17 min / MSP (weeks 1 and 9 excluded).
Q: How many days before the due date do students start working on MSPs?
A: MSPs started 2.2 days before due date
A: But with policy adjustment in Fall, started 5.3 days before
Q: What % of MSPs do students complete each day?
A: Completed ~10% of MSPs each day
Q: Given a full-credit threshold, do students complete more MSPs than required?
A: 40% of students completed more MSPs than required

No extra credit given for exceeding full-credit threshold
A: Total points per week -- Avg 13 more points

Bubble size represents number of students. Dashed line indicates full-credit threshold. Students who scored 0 points for a week excluded.
Q: Do students pivot, or switch among MSPs when stuck?
A: Each week, 50% of students pivoted (avg. 1.3 pivots)
Pivot Pattern
Q: Do students use MSPs to study for exams?
A: Yes, students use MSPs to study for exams

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<table>
<thead>
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<tbody>
<tr>
<td>Total number of students</td>
<td>76</td>
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<tr>
<td>Total number of MSPs</td>
<td>61</td>
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<tr>
<td>% of students that used MSPs to study for the midterm</td>
<td>38%</td>
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<tr>
<td>% of students that used MSPs to study for the final</td>
<td>37%</td>
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<tr>
<td>% of students that used MSPs to study for either exam</td>
<td>54%</td>
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<td>% of MSPs that were used to study for the midterm</td>
<td>97%</td>
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<td>% of MSPs that were used to study for the final</td>
<td>90%</td>
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<tr>
<td>% of MSPs that were used to study for either exam</td>
<td>98%</td>
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Q: Won't MSP CS1 students do poorly in an OLP CS2?
A: MSP CS1 students do fine in an OLP CS2, in fact slightly better
Student Feedback

- Good practice
- They are engaging and fun
- Short and simple tasks to improve my coding
- They give me enough practice to know the material

Solving the lab activities is kind of fun.
59 responses

- Strongly agree: 59.3%
- Slightly agree: 25.4%
- Slightly disagree: 13.6%
- Strongly disagree: 2.7%

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Conclusion

Students make good use of MSPs

- Previous work: +confidence/stress, +coding
- Sufficient time
- Started early
- Completed more than necessary
- Pivoted to help selves when stuck
- Used MSPs to study for exams

And, MSP CS1 students do just as well as OLP CS1 students in an OLP CS2.