An Analysis of Using Many Small Programs in CS1
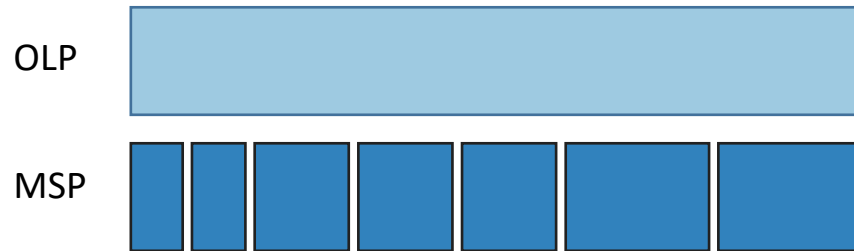
By: **Joe Michael Allen**[1], Frank Vahid[1,2], Alex Edgcomb[1,2], Kelly Downey[1], and Kris Miller[1]
[1]Computer Science and Engineering, University of California, Riverside
[2]zyBooks, Los Gatos, California

OLP

MSP

Traditional: One Large Program (OLP) each week
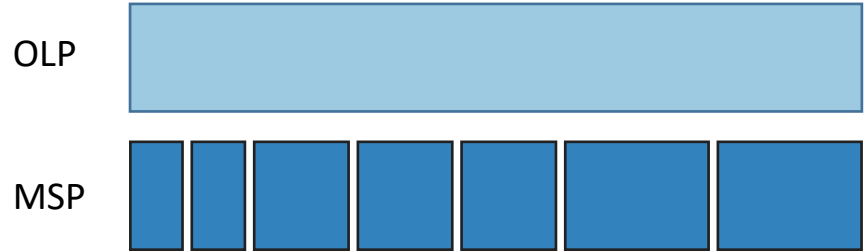
- Solution 50-200 lines
- Long spec

OLP

Many Small Programs (MSPs) each week

Our approach: 5-7 MSPs

- Solution 10-50 lines each
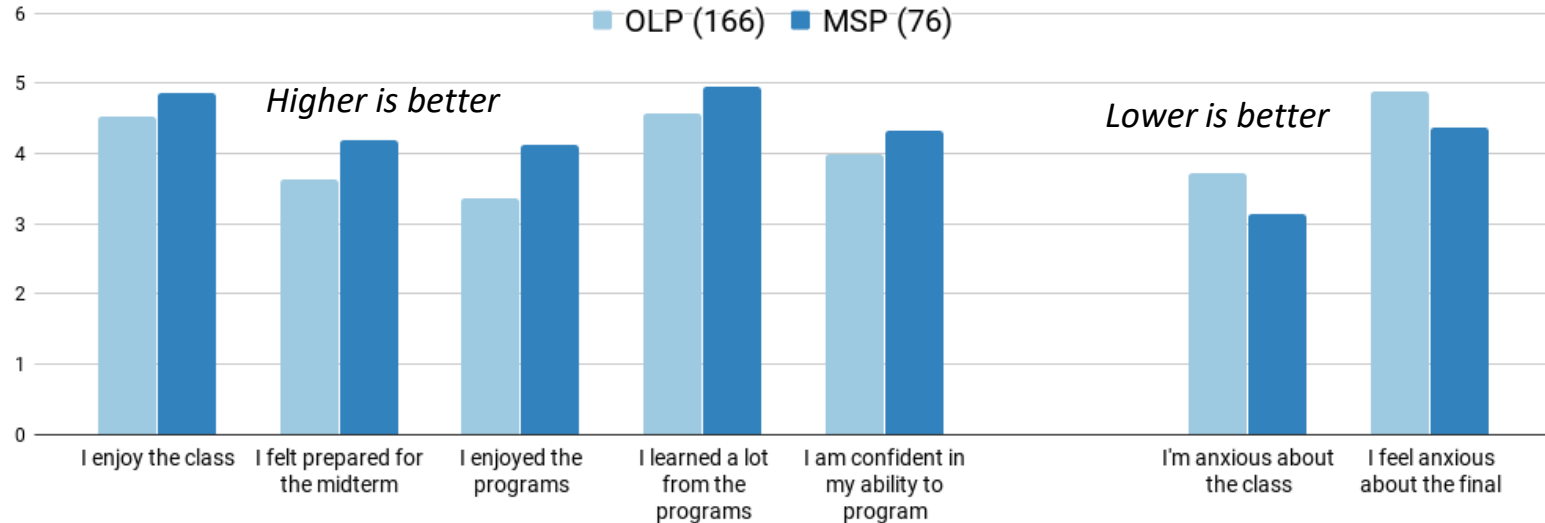- Short & concise spec

Benefits

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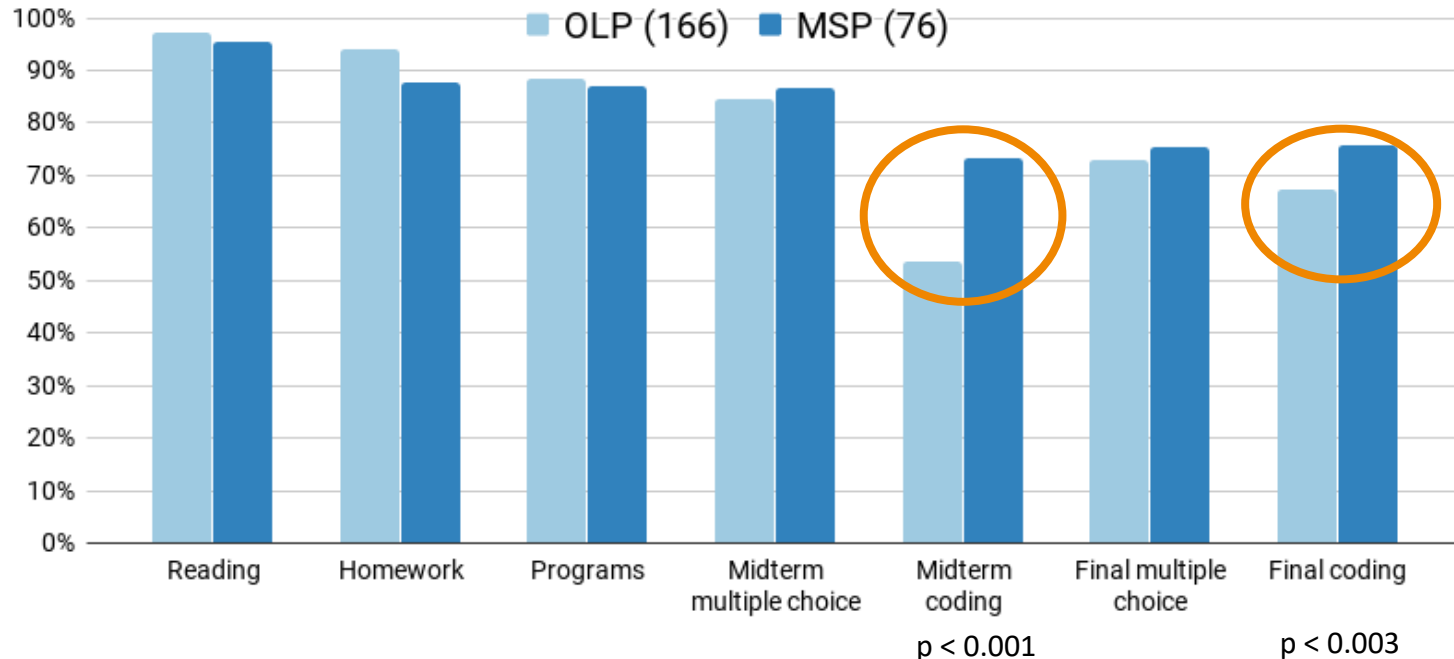
OLP

MSP

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

Previous: MSP impact on learning?

Dozens of schools have switched to MSPs, many using UCR's MSPs
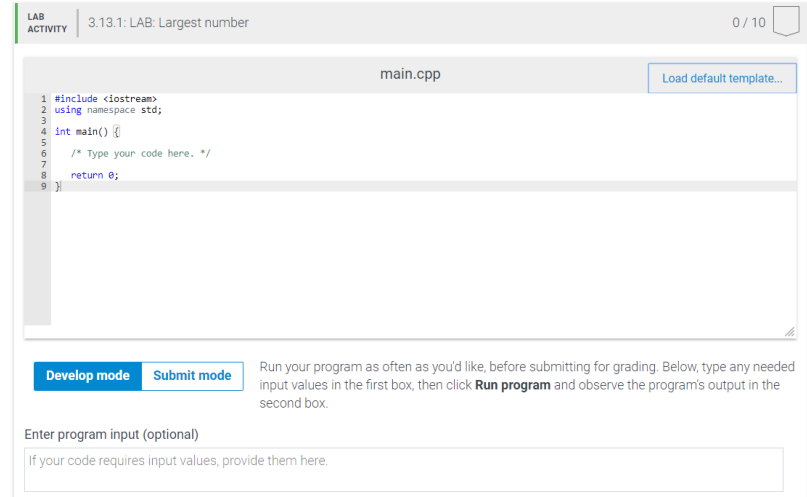(orig C++, now Java, Python, and C), reporting good results.

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?**
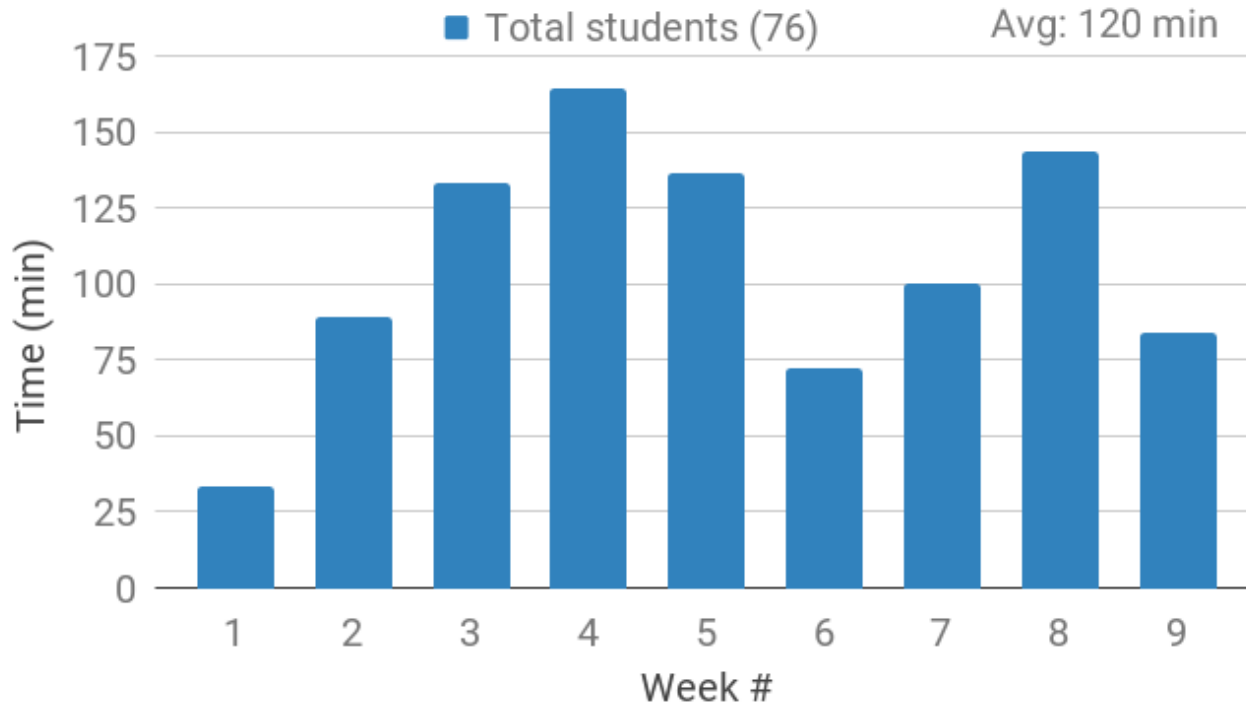
"Fact-finding mission"

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,

main.cpp   Load default template...

```
1  #include <iostream>
2  using namespace std;
3
4  int main() {
5
6      /* Type your code here. */
7
8      return 0;
9  }
```

Develop mode Submit mode   Run your program as often as you'd like, before submitting for grading. Below, type any needed input values in the first box, then click **Run program** and observe the program's output in the second box.

Enter program input (optional)

If your code requires input values, provide them here.

labID		userID	score	maxScore	timestamp
14	CH1 LAB: Formatted output: No parking sign	31228			4/8/2018 22:55
15	CH1 LAB: Formatted output: No parking sign	31228			4/8/2018 22:55
16	CH1 LAB: Formatted output: No parking sign	31228	10	10	4/8/2018 22:55
17	CH1 LAB: Input: Welcome message	31228			4/8/2018 22:57
18	CH1 LAB: Input: Welcome message	31228	10	10	4/8/2018 22:58
19	CH1 LAB: Input: Mad Lib	31228			4/8/2018 23:01
20	CH1 LAB: Input: Mad Lib	31228			4/8/2018 23:02
21	CH1 LAB: Input: Mad Lib	31228			4/8/2018 23:02
22	CH1 LAB: Input: Mad Lib	31228			4/8/2018 23:03
23	CH1 LAB: Input: Mad Lib	31228	10	10	4/8/2018 23:03
24	CH1 LAB: Input and formatted output: House real estate summary	31228			4/8/2018 23:08
25	CH1 LAB: Input and formatted output: House real estate summary	31228			4/8/2018 23:08

Q: How much time do students spend working on MSPs each week?
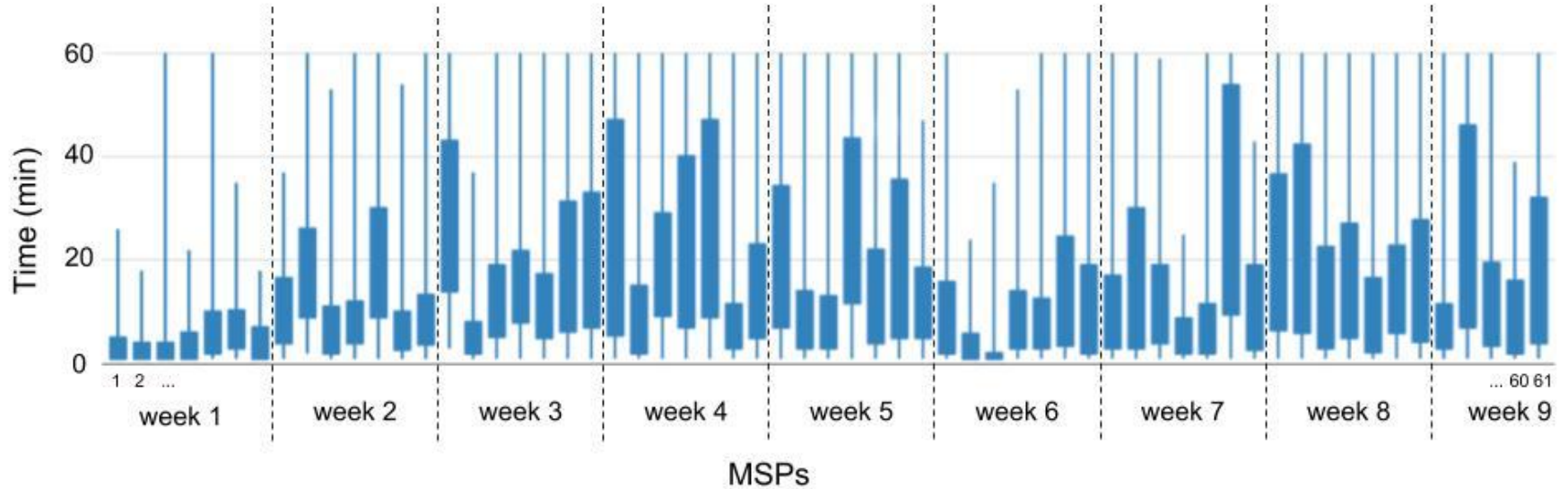
A: At least 120 min / week

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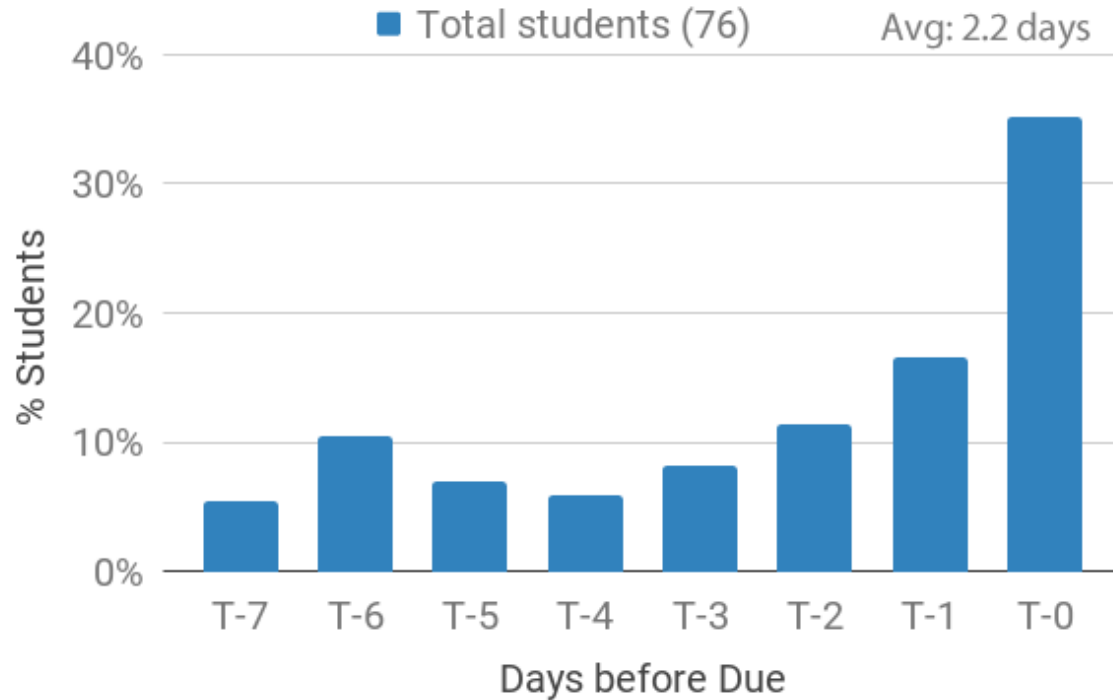
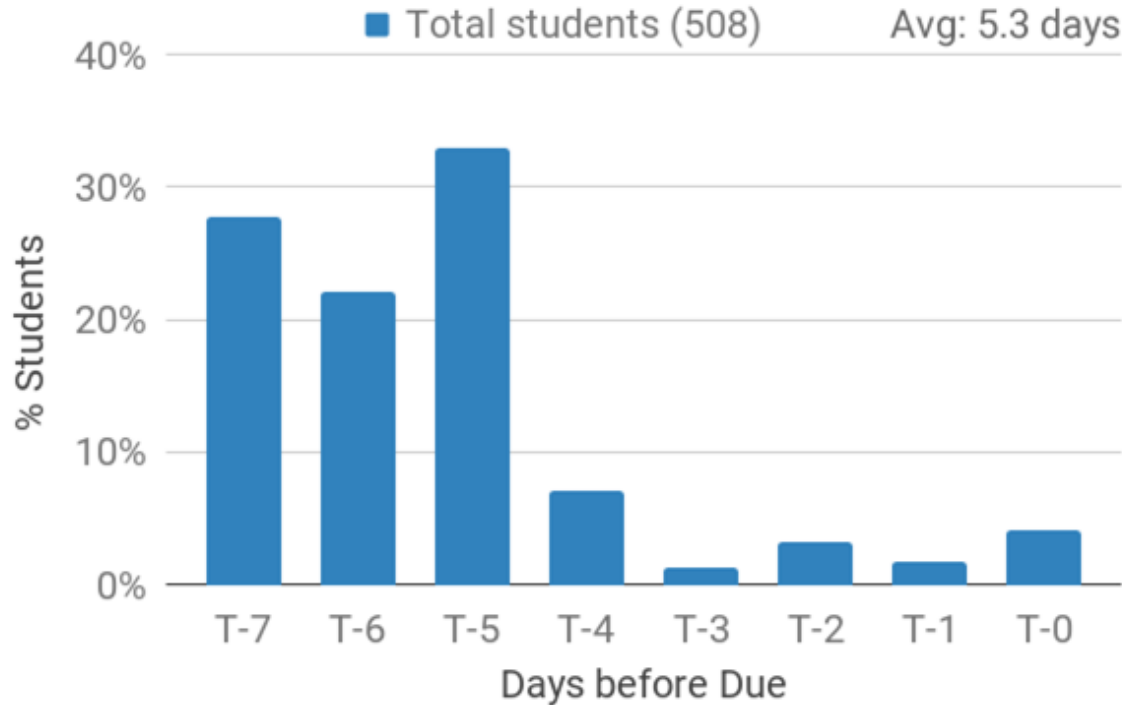# A: About 17 min per MSP

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?
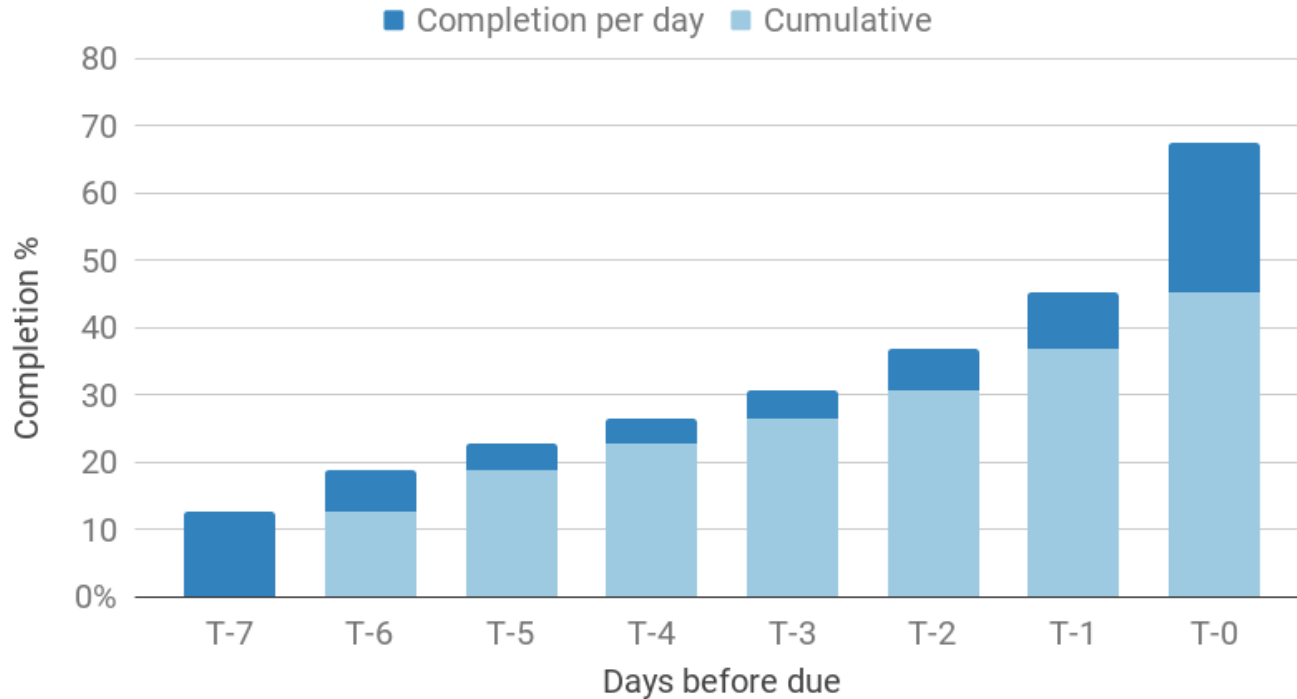
A: MSPs started 2.2 days before due date

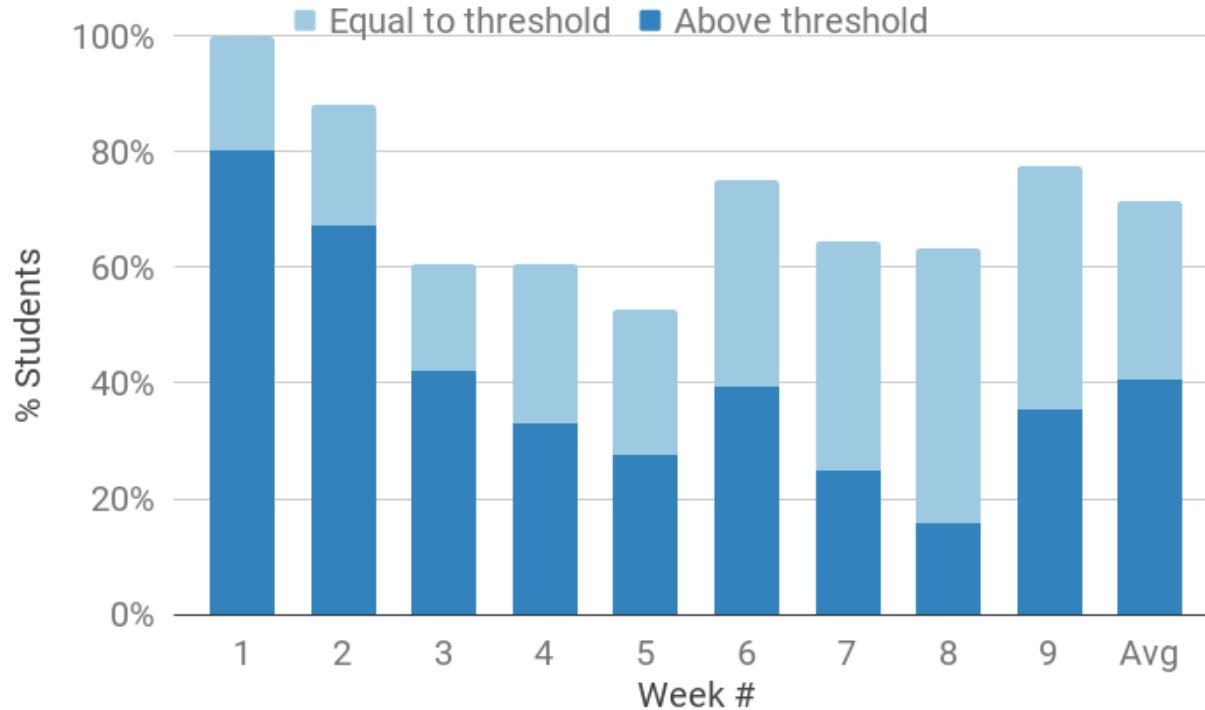# A: But with policy adjustment in Fall, started 5.3 days before

Q: What % of MSPs do students complete each day?
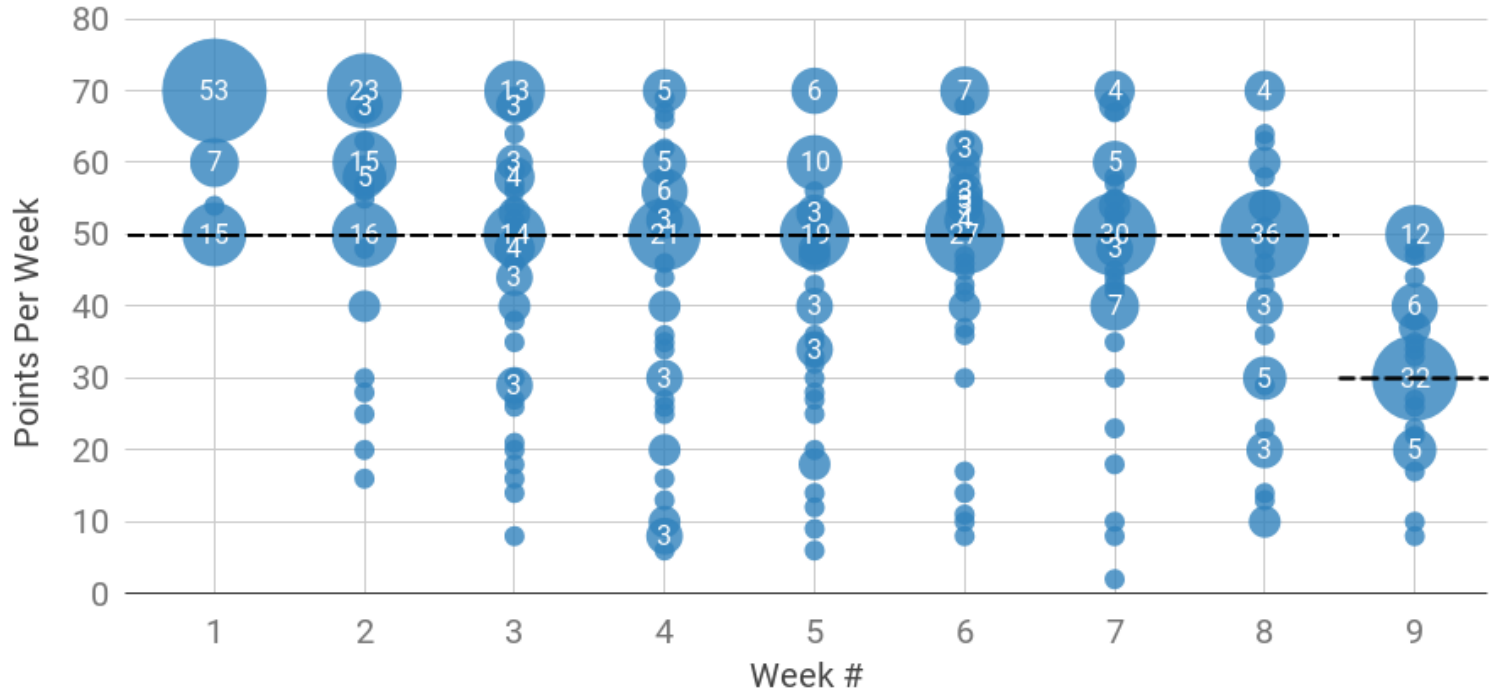
A: Completed ~10% of MSPs each day

Q: Given a full-credit threshold, do students complete more MSPs than required?

A: 40% of students completed more MSPs than required

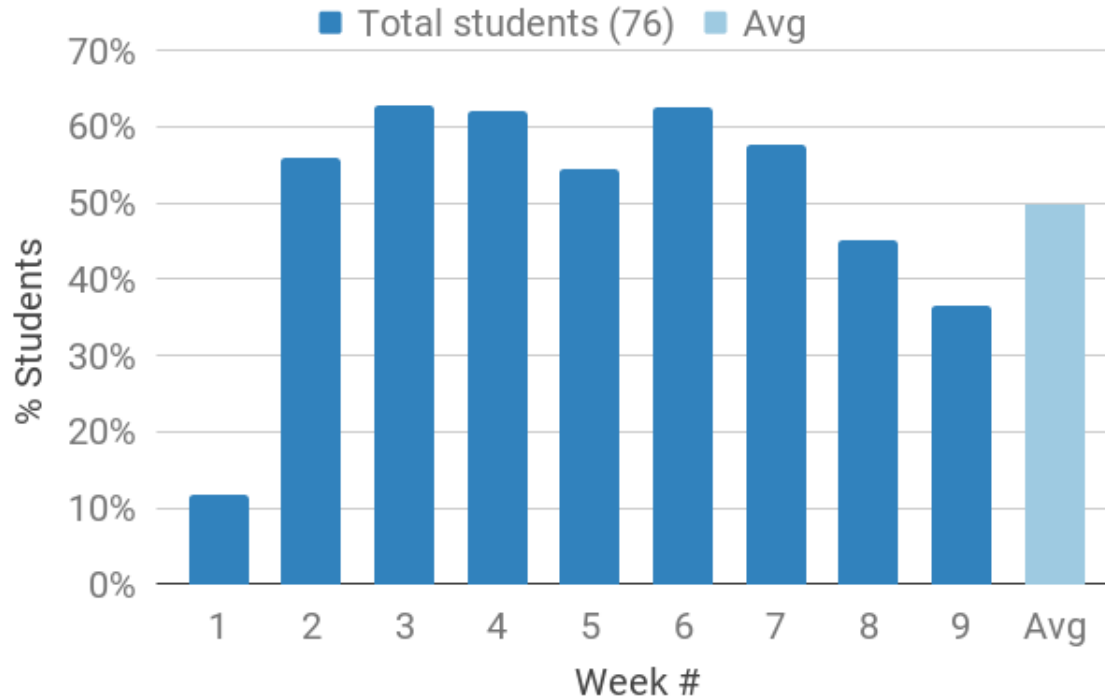No extra credit given for exceeding full-credit threshold

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.
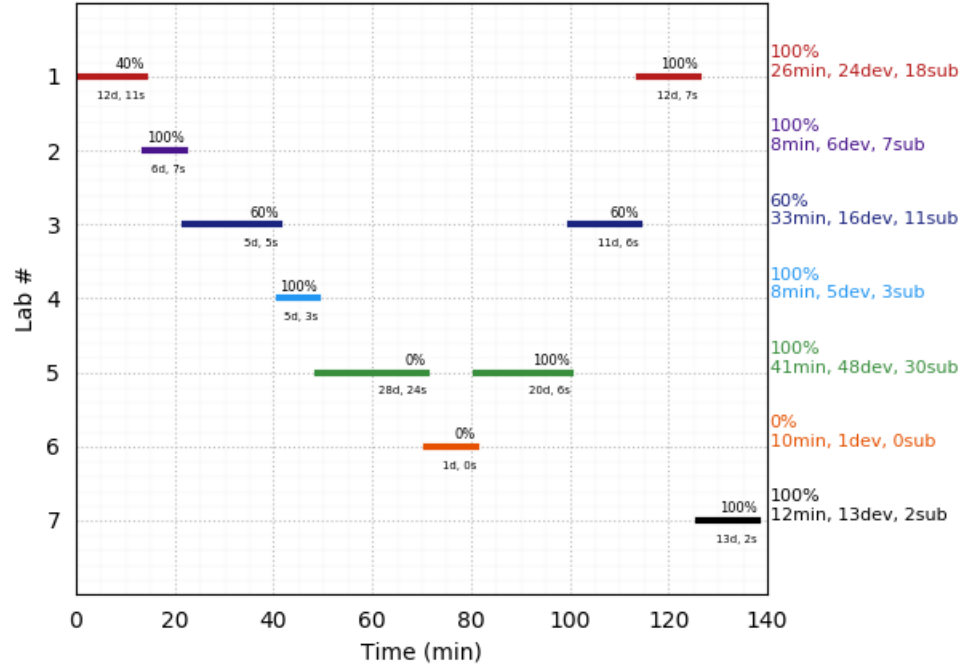
Q: Do students pivot, or switch among MSPs when stuck?

A: Each week, 50% of students pivoted (avg. 1.3 pivots)

Pivot Pattern

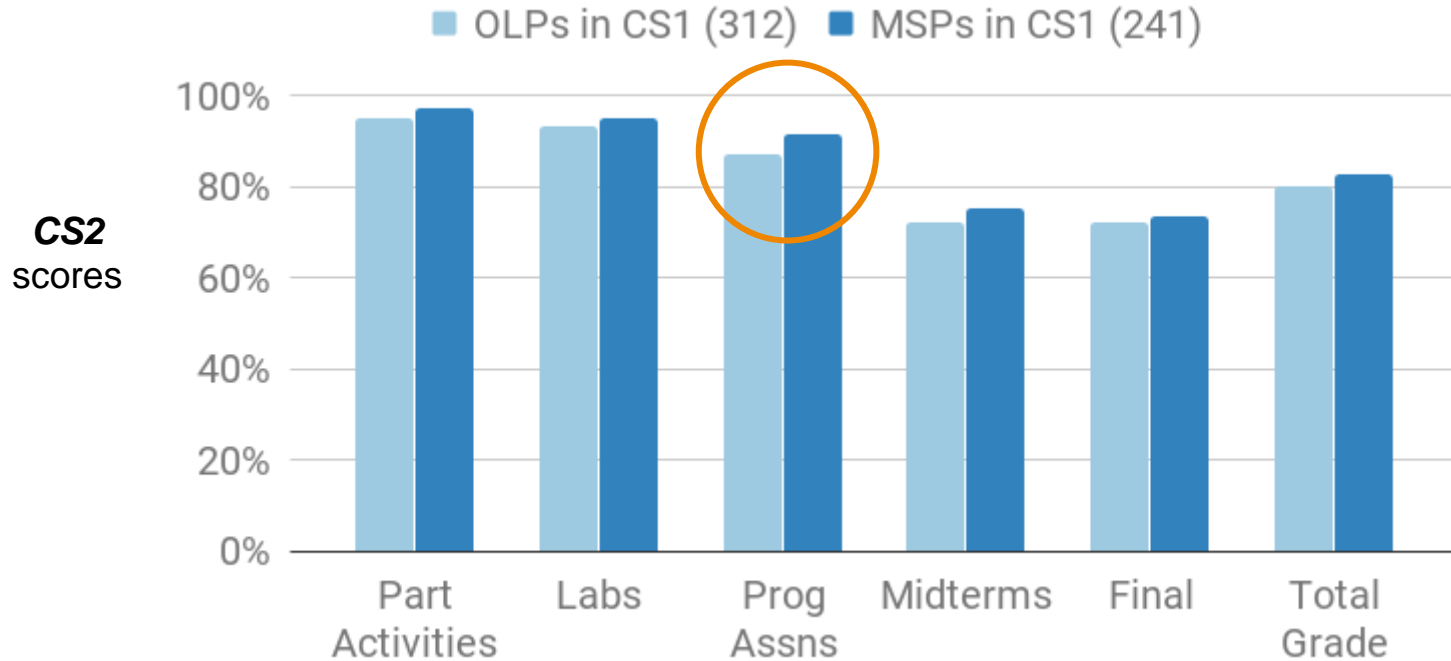64046 Week 2 Lab Gantt Chart (138min, 113dev, 71sub)

Q: Do students use MSPs to study for exams?

A: Yes, students use MSPs to study for exams

Total number of students	76
Total number of MSPs	61
% of students that used MSPs to study for the midterm	38%
% of students that used MSPs to study for the final	37%
% of students that used MSPs to study for either exam	**54%**
% of MSPs that were used to study for the midterm	97%
% of MSPs that were used to study for the final	90%
% of MSPs that were used to study for either exam	**98%**

Q: Won't MSP CS1 students do poorly in an OLP CS2?

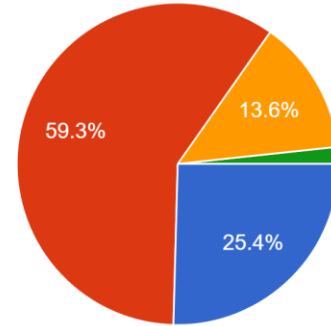# A: MSP CS1 students do fine in an OLP CS2, in fact slightly better

CS2 scores

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
- Slightly agree
- Slightly disagree
- Strongly disagree

59.3%

13.6%

25.4%

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.

OLP

MSP

CS2 scores