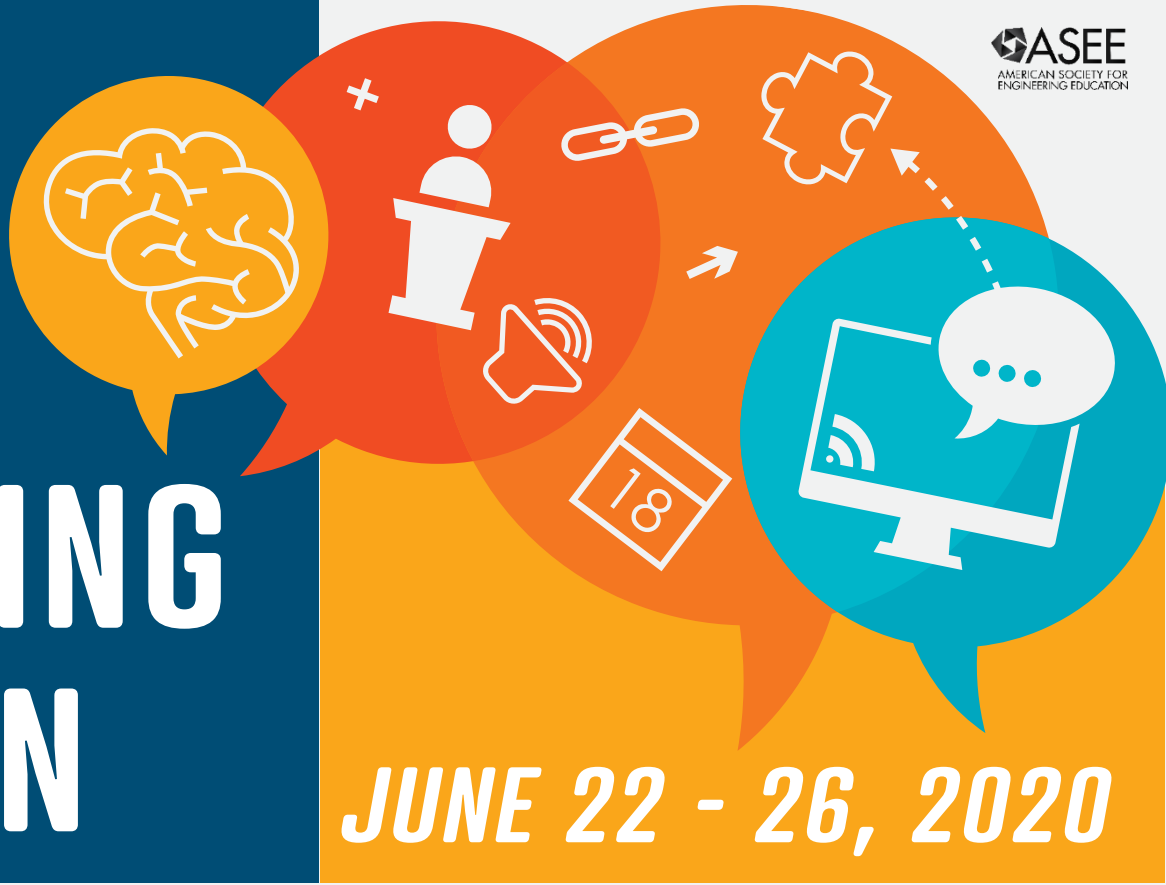
AT HOME WITH ENGINEERING EDUCATION



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JUNE 22 - 26, 2020

At Home with Engineering Education

Analyzing Pivoting Among Weekly Many Small Programs in a CS1 Course

Joe Michael Allen[1] and Frank Vahid[1,2]

[1]University of California, Riverside
[2]zyBooks

CS1 is important

Positive experience in a CS1 course is critical for student success

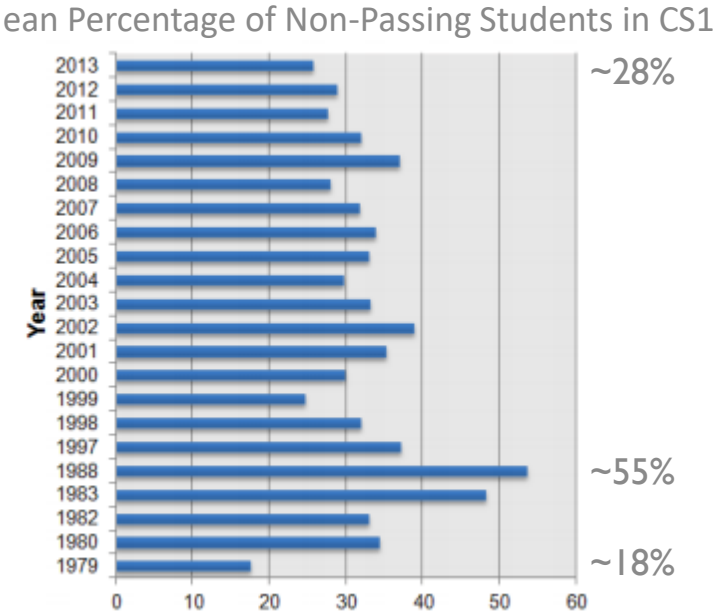
- Keeps students in computer science (CS)
- Trains non-major students
- Attracts students to CS

Problem

CS1 issues:

- High student stress
- Student dissatisfaction
- Academic dishonesty
- Low grades
- High non-passing rates

~ 30% non-passing rate over the past 30 years

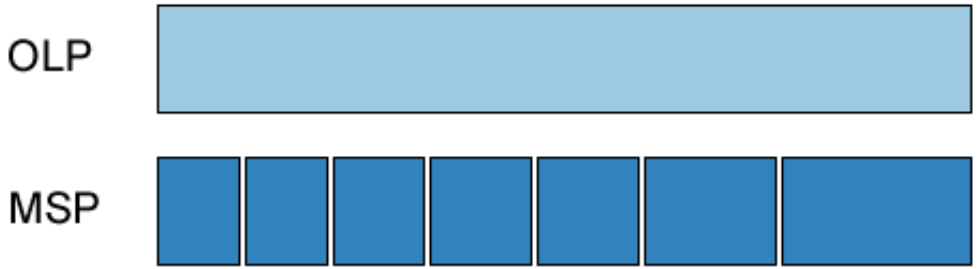


Watson, C. and Li, F. "Failure Rates in Introductory Programming Revisited, " iTiCSE, 2014
http://dro.dur.ac.uk/19223/1/19223.pdf%3FDDD10%2Bd74ks0%2Bdcs0lw

Many small programs (MSPs)

MSP teaching approach

- Multiple assignments per week (5-7)
- Small assignments (20-50 LOC)
- Specific concepts



MSP benefits

Study 1 (2018):

- Student grades improved (especially on exams)
- Students were happier and less stressed
- As a result, all CS1 classes switched to MSPs

J. M. Allen, F. Vahid, K. Downey, and A. Edgcomb, "Weekly Programs in a CS1 Class: Experiences with Auto-graded Many-small Programs (MSP)," in Proceedings of ASEE Annual Conference, 2018.

Study 2 (2019):

- Spend good time each week working on their programming assignments
- Start working on programming assignments early
- Use more programs to study for exams
- Ability to pivot
- And more…

Did not harm student performance in CS2

J. M. Allen, F. Vahid, A. Edgcomb, K. Downey, and K. Miller, "An Analysis of Using Many Small Programs in CS1," in ACM SIGCSE Technical Symposium on Computer Science Education, 2019.

Pivoting

Switch among programming assignments while working

CS1 course details

University of California, Riverside

- U.S. public research university, whose CS department typically ranks in the top 60 by U.S. News and World Report
- Operate on a quarter system (10 weeks)

Course

- Serves around 300-500 students each quarter: half computing majors and half non-computing majors
- Course topics (C++): basic input/output, assignments, branches, loops, functions, and vectors
- 3 hours of instructor-led lecture, 3 hours of TA-led labs, interactive online readings, and auto-graded homework assignments

Data collection

	labID	userD	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

Winter 2019 CS1 course section

- 78 students
- Taught with MSP approach
  - 7 assignments per week with full-credit threshold (70%) (70 points total; 49 points full credit)
- Online textbook published by zyBooks
- Collected all student develops and submits for every programming assignment
  - 65 MSPs; 34,316 develops; 14,774 submits; total of 49,090 student activities

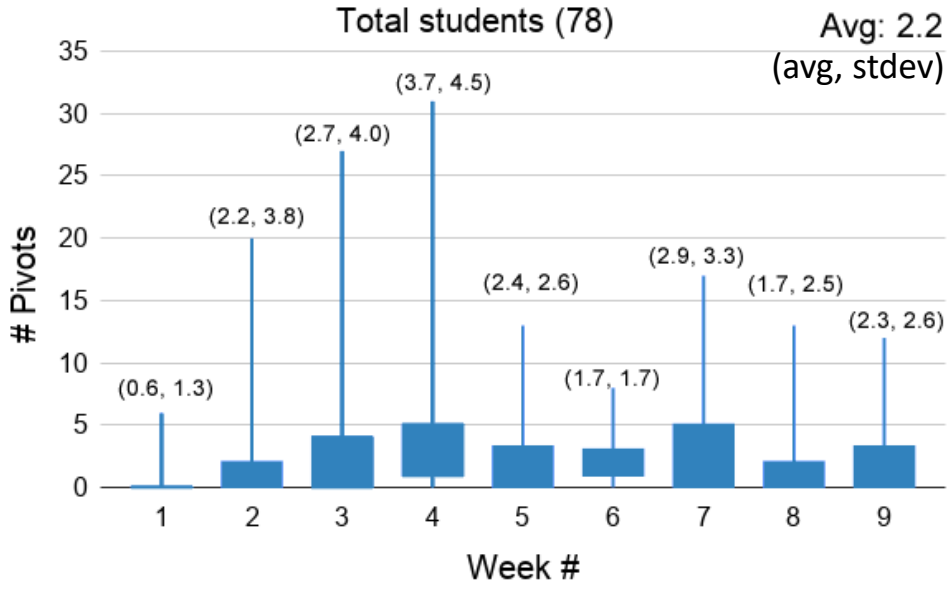
Pivot definition

A pivot is when a student partially completes a program (e.g., scores 8 of 10 points) and then chooses to work on a different program

1. The activity is not the student's first activity for the week
2. The activity is for a different program than the previous activity
3. The activity is for a program that has not been completed
4. The previous activity is for a program that has not been completed
5. The activity and previous activity are for programs assigned in the same week

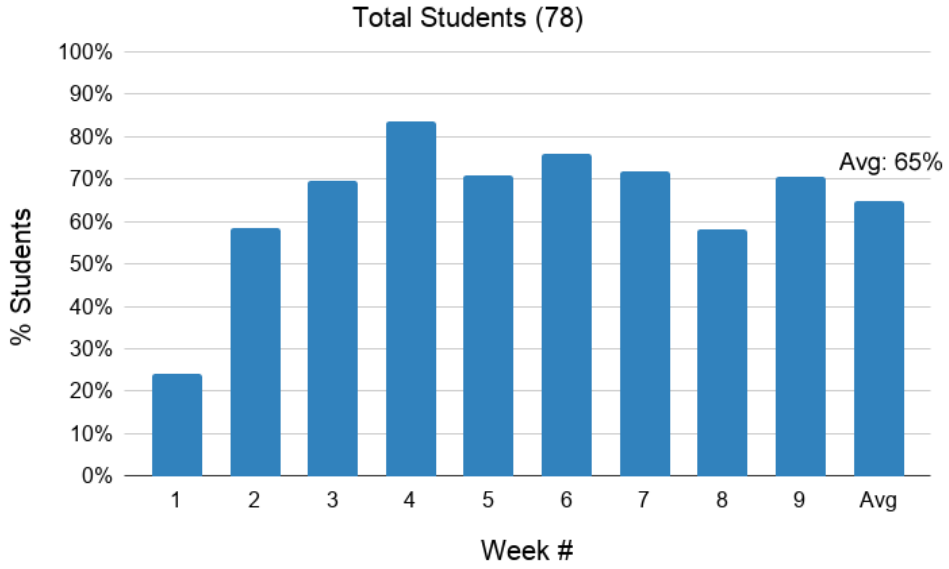
Q: How many times do students pivot each week?

A: Avg 2.2 times per week



Q: What percent of students pivot each week?

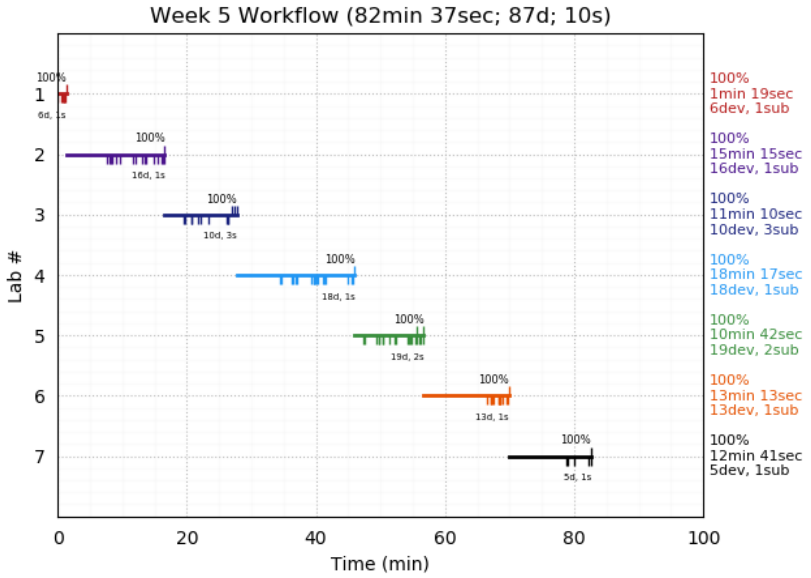
A: Avg 65% students pivot once each week



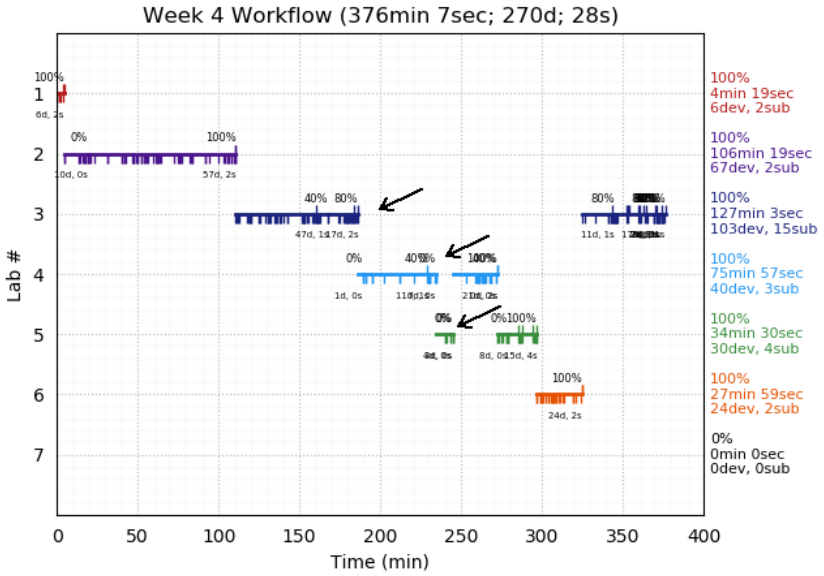
Q: What are some observed pivot patterns?

- A GANTT chart shows activities displayed against time. Each activity is represented by a bar; the position and length of the bar reflects the start date, duration and end date of the activity
  - Time spent
  - # submissions & # develops
  - Total score earned

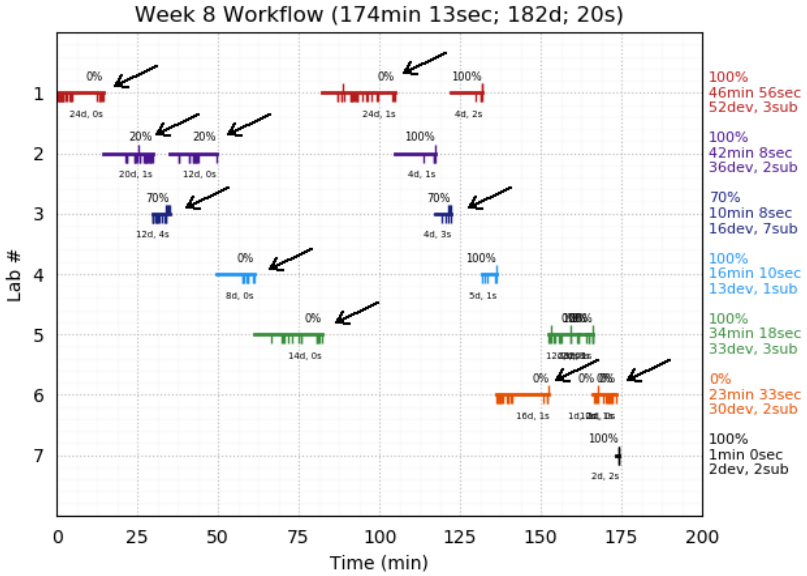
Pattern 1: 0 pivots



Pattern 2: 3 pivots

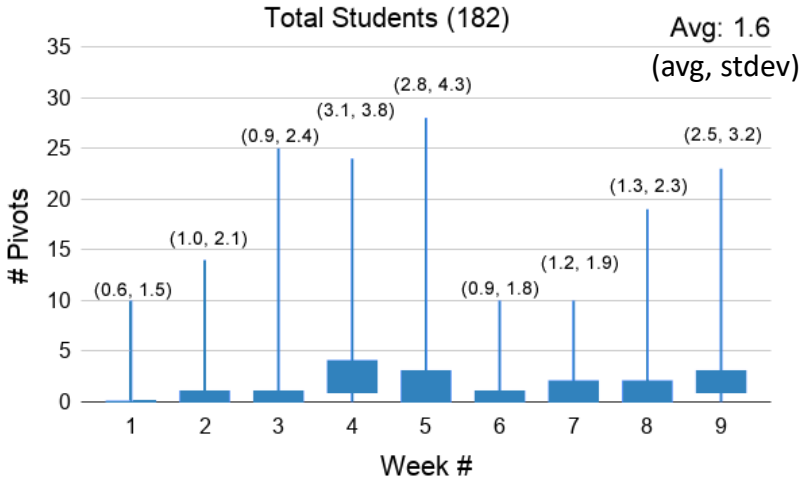


Pattern 3: 10 pivots

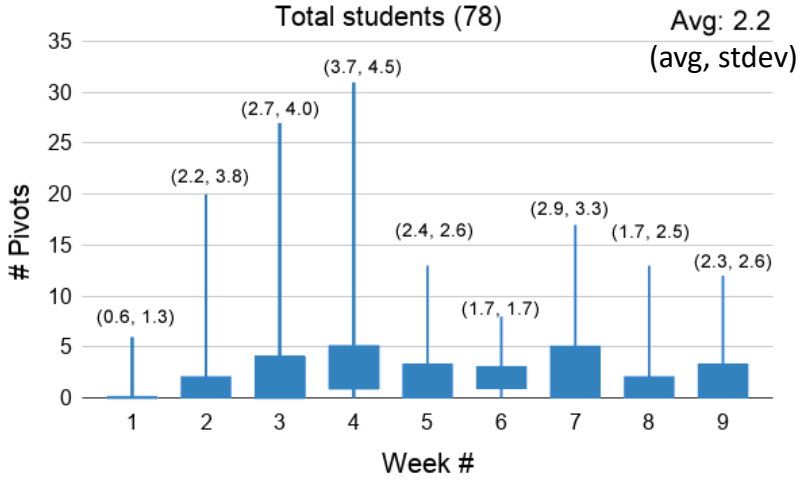


Q: Do students pivot more or less given a full-credit threshold?

A: Yes, 1.6 pivots vs. 2.2 pivots



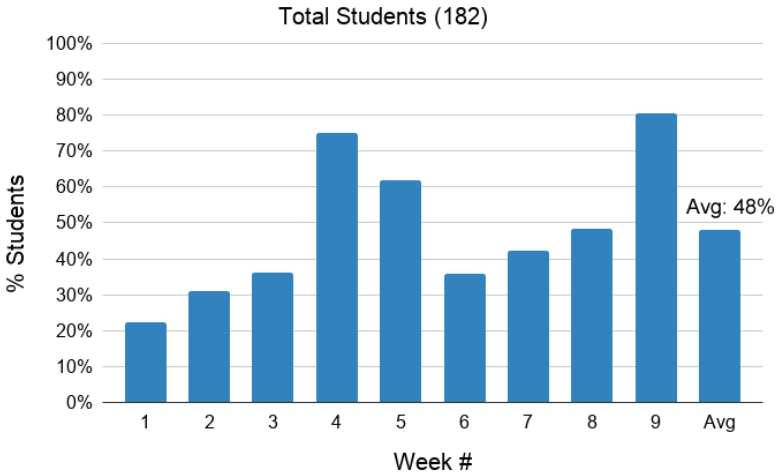
Pivots without a full-credit threshold



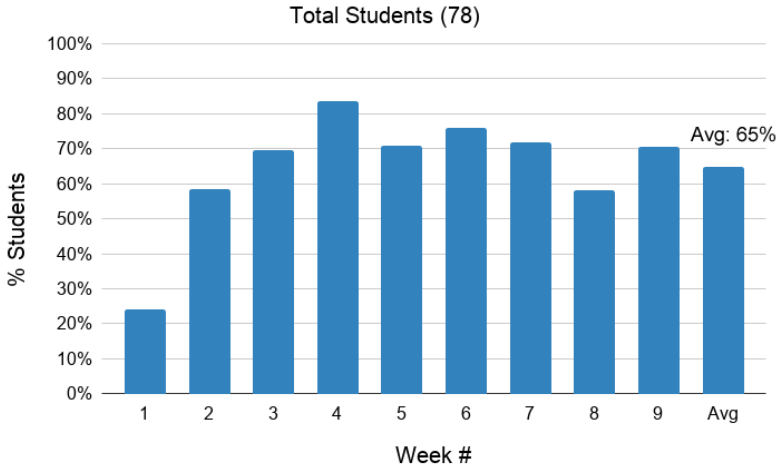
Pivots with a full-credit threshold

Q: Do students pivot more or less given a full-credit threshold?

A: Yes, 48% students vs. 65% students



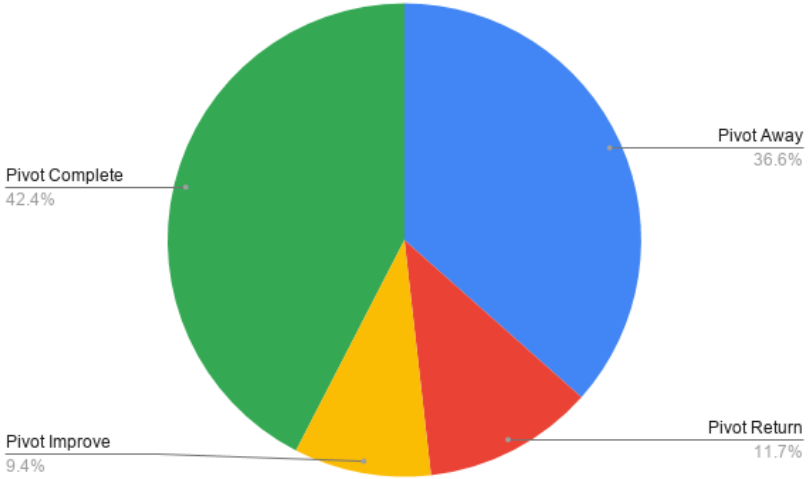
% students pivot without a full-credit threshold



% students pivot with a full-credit threshold

Q: Do students return to complete the original problem they pivot from?

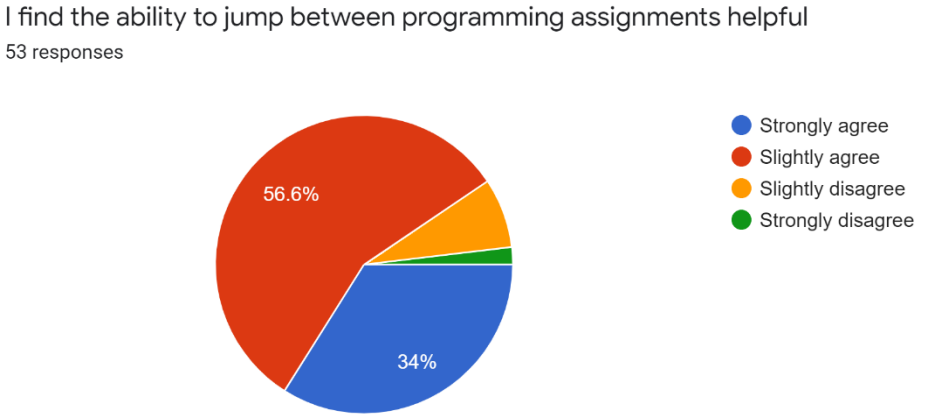
A: Yes, ~65% return



Student feedback

Week 5 student survey

- I find the ability to jump between programming assignments helpful.
- 4-point Lickert scale
- Average response was 3.23, between "Slightly agree" and "Strongly agree."



Conclusion

- Benefit of MSP approach: students can pivot, meaning to switch among programs when stuck.

- Results:
  - Students pivot **2.2 times** each week on average
  - A majority of students **(65%)** make use of pivoting each week.
  - See that students display different **pivoting patterns**
  - Given a full-credit threshold, **students do pivot more** than students not given a full-credit threshold.
  - When a student pivots away, they usually **return to work** on the program again.

Email: jalle010@ucr.edu