

Many Small Programs in CS1: Usage Analysis from Multiple Universities



2.24 CH2 LAB: Phone number breakdown

Visible to students Edit lab Note

Given a long long integer representing a 10-digit phone number, output the area code, prefix, and line number, separated by hyphens. If the input is 8005551212, the output is: 800-555-1212

Hint: Use % to get the desired rightmost digits. Ex: The rightmost 2 digits of 572 is gotten by $572 \% 100$, which is 72.

Hint: Use / to shift right by the desired amount. Ex: Shifting 572 right by 2 digits is done by $572 / 100$, which yields 5. (Recall integer division discards the fraction).

For simplicity, assume any part starts with a non-zero digit. So 999-011-9999 is not allowed.

```
LAB ACTIVITY | 2.24.1: CH2 LAB: Phone number breakdown | 0 / 10
main.cpp | Load default template...
1 #include <iostream>
2 using namespace std;
3
4 int main() {
5     long long phoneNumber;
6
7     cin >> phoneNumber;
8
9     /* Type your code here */
10
11     return 0;
12 }
13
```

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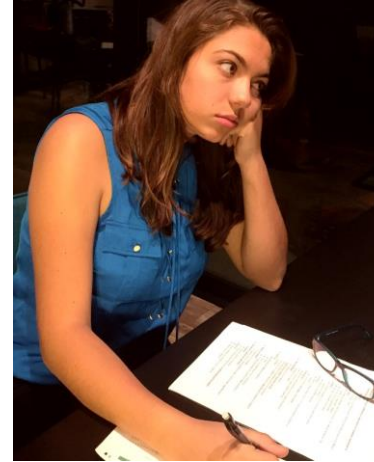
Research outset: Spring 2017

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

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



Enabled by new auto-graders

- Easy to create / Instant feedback
- zyLabs (zyBooks): ~30 min create lab

MSP sample

Specification

3.15 CH3 LAB: School type (branches) Visible to students Edit lab Share Note

Write a program that takes an integer as input, representing a year in school. Output "Elementary school" for 0-5, "Middle school" for 6-8, "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
```

Template Code

LAB ACTIVITY | 3.15.1: CH3 LAB: School type (branches) 0 / 10

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 }
10
```

Assessment

1. Compare output (2 points)

When input is

Standard output exactly matches

2. Compare output (1 point)

When input is

Standard output exactly matches

MSP walkthrough

zyBooks My library > CS 10 Online: Vahid home Adopt a zyBook Help/FAQ Joe Allen

Search zyBook Search Configure zyBook

Showing activity for Entire class

	zyLabs	Challenge	Participation
<input type="checkbox"/> 1. Introduction	94%	98%	97%
<input type="checkbox"/> 2. Variables/Assignments	85%	96%	98%
<input type="checkbox"/> 3. Branches	69%	95%	98%
<input type="checkbox"/> 3.1 If-else		96%	98%
<input type="checkbox"/> 3.2 Relational and equality operators		96%	98%
<input type="checkbox"/> 3.3 Multiple if-else branches		95%	97%
<input type="checkbox"/> 3.4 Logical operators		94%	98%
<input type="checkbox"/> 3.5 Boolean data types		94%	98%
<input type="checkbox"/> 3.6 Floating-point comparison		93%	98%
<input type="checkbox"/> 3.7 C++ example: Salary calculation with branches			97%
<input type="checkbox"/> 3.8 CH3 LAB: Output with groupings: Vending machine	69%		
<input type="checkbox"/> 3.9 CH3 LAB: Largest number	92%		
<input type="checkbox"/> 3.10 CH3 LAB: Remove gray from RGB	74%		
<input type="checkbox"/> 3.11 CH3 LAB: Leap Year	84%		
<input type="checkbox"/> 3.12 CH3 LAB: Interstate highway numbers	73%		
<input type="checkbox"/> 3.13 CH3 LAB: Seasons	46%		
<input type="checkbox"/> 3.14 CH3 LAB: Exact change	46%		

CS 10 Online: Vahid

Spring 2017

View activity and create a report

1. Select chapters and sections in the table of contents on the left.

Alternatively, select an assignment below

2. Then select class and time options below.

Entire class

Jun 15th, 2019 11:59 PM PDT

All activity from start of class until 11:59 PM US/Pacific time will be downloaded

[Download report](#)

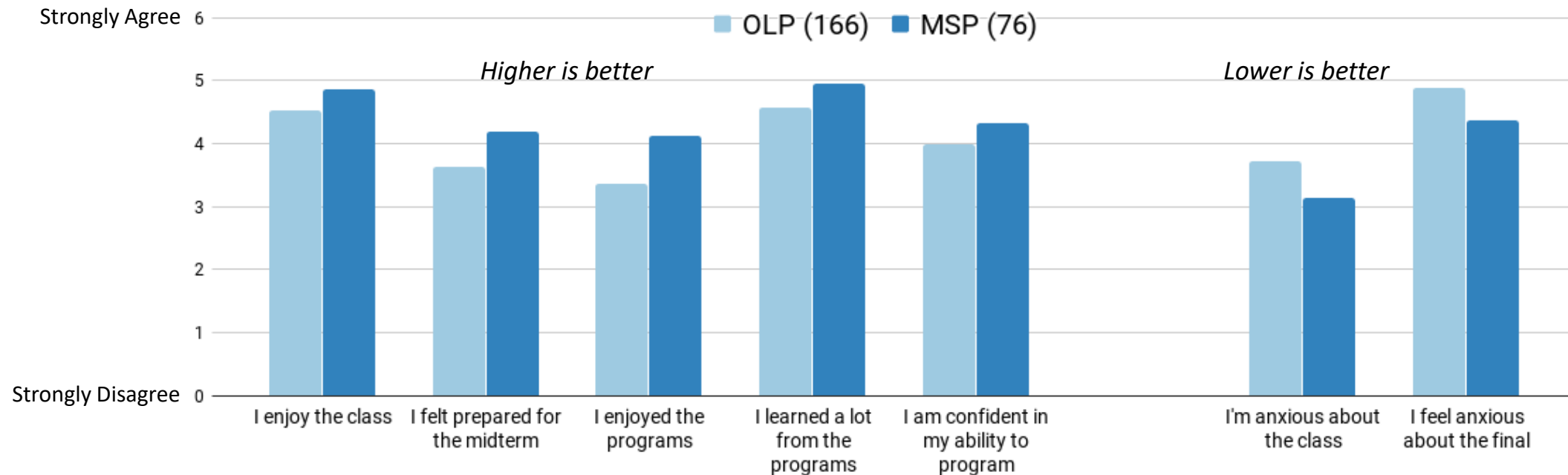
You must select at least one section to the left to download a report.

Getting startedMy classReportingAssignments

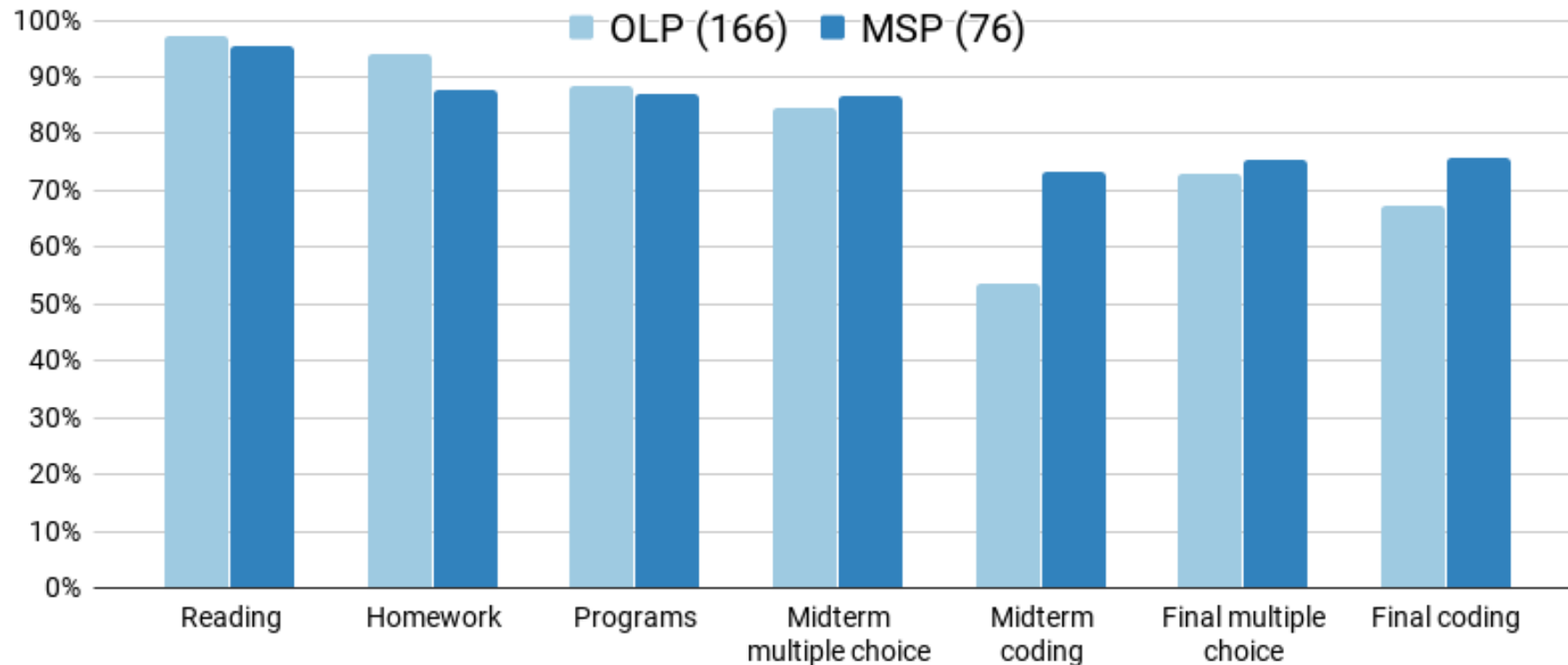
Previous work: MSP impact on student satisfaction

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



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

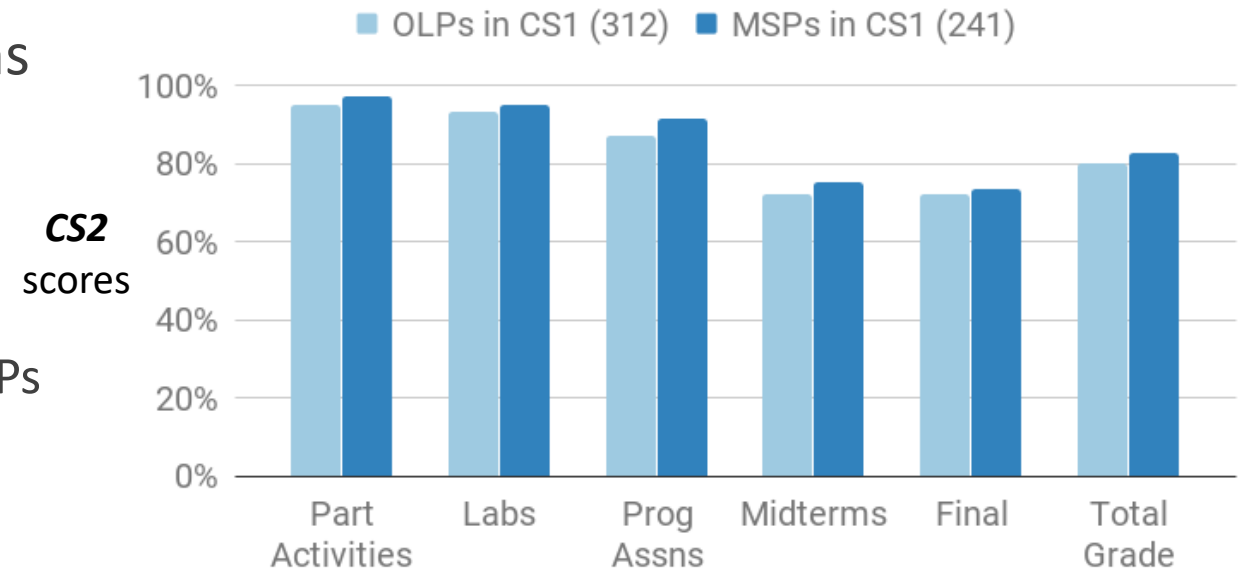
Previous work: MSP usage analysis - UCR

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

	Prog Language	#Students	# MSPs	# Submissions collected	# Develops collected
University 1	C++	20	98	3177	5635
University 2	Python	81	69	19244	19707
University 3	C++	30	19	2397	3416
University 4	C++	14	61	1675	5104
University 5	Java	11	51	643	3535
University 6	C++	234	77	21451	40573
University 7	Python	333	43	88981	103089
University 8	C++	79	25	7315	9298
University 9	Java	56	59	7454	18505
University 10	Java	321	65	40320	96721

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)

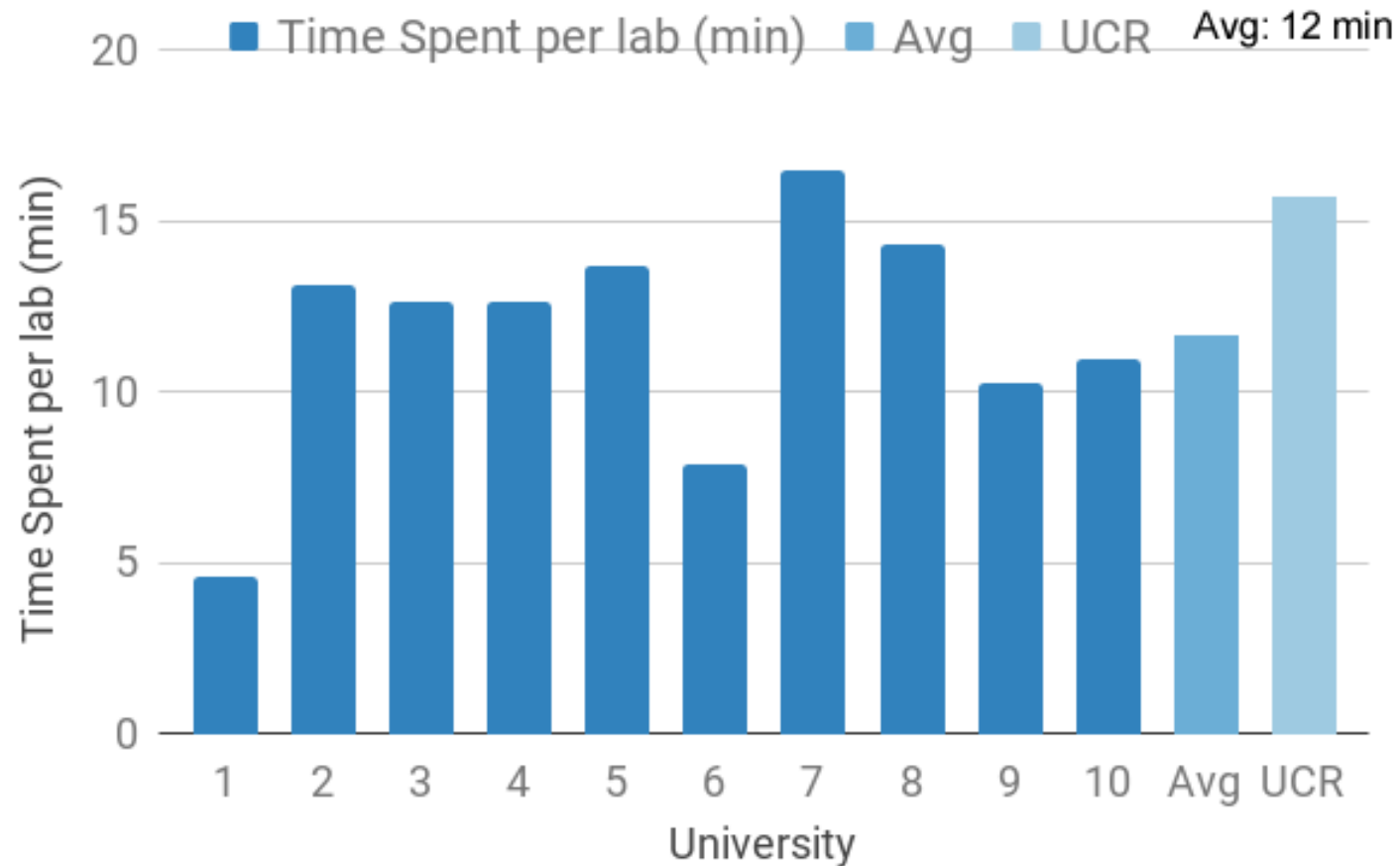
Collected:

- 302,406 develops & 192,657 submissions

labID	userID	score	maxScore	timestamp	zip
CH1 LAB: Input: Mad Lib	10365			4/6/2017 1:08	https://
CH1 LAB: Input: Mad Lib	10365			4/6/2017 1:09	https://
CH1 LAB: Input and formatted output: House real estate summary	10365	10	10	4/6/2017 1:10	https://
CH1 LAB: Input and formatted output: House real estate summary	10365			4/6/2017 1:22	https://
CH1 LAB: Input and formatted output: House real estate summary	10365			4/6/2017 1:22	https://
CH1 LAB: Input and formatted output: House real estate summary	10365			4/6/2017 1:24	https://
CH1 LAB: Input and formatted output: House real estate summary	10365			4/6/2017 1:25	https://
CH1 LAB: Input and formatted output: House real estate summary	10365			4/6/2017 1:26	https://
CH1 LAB: Input and formatted output: House real estate summary	10365			4/6/2017 1:26	https://
CH1 LAB: Input and formatted output: House real estate summary	10365			4/6/2017 1:26	https://
CH1 LAB: Input and formatted output: House real estate summary	10365			4/6/2017 1:27	https://
CH1 LAB: Input and formatted output: House real estate summary	10365			4/6/2017 1:29	https://

Q: How much time do students spend working on each MSP?

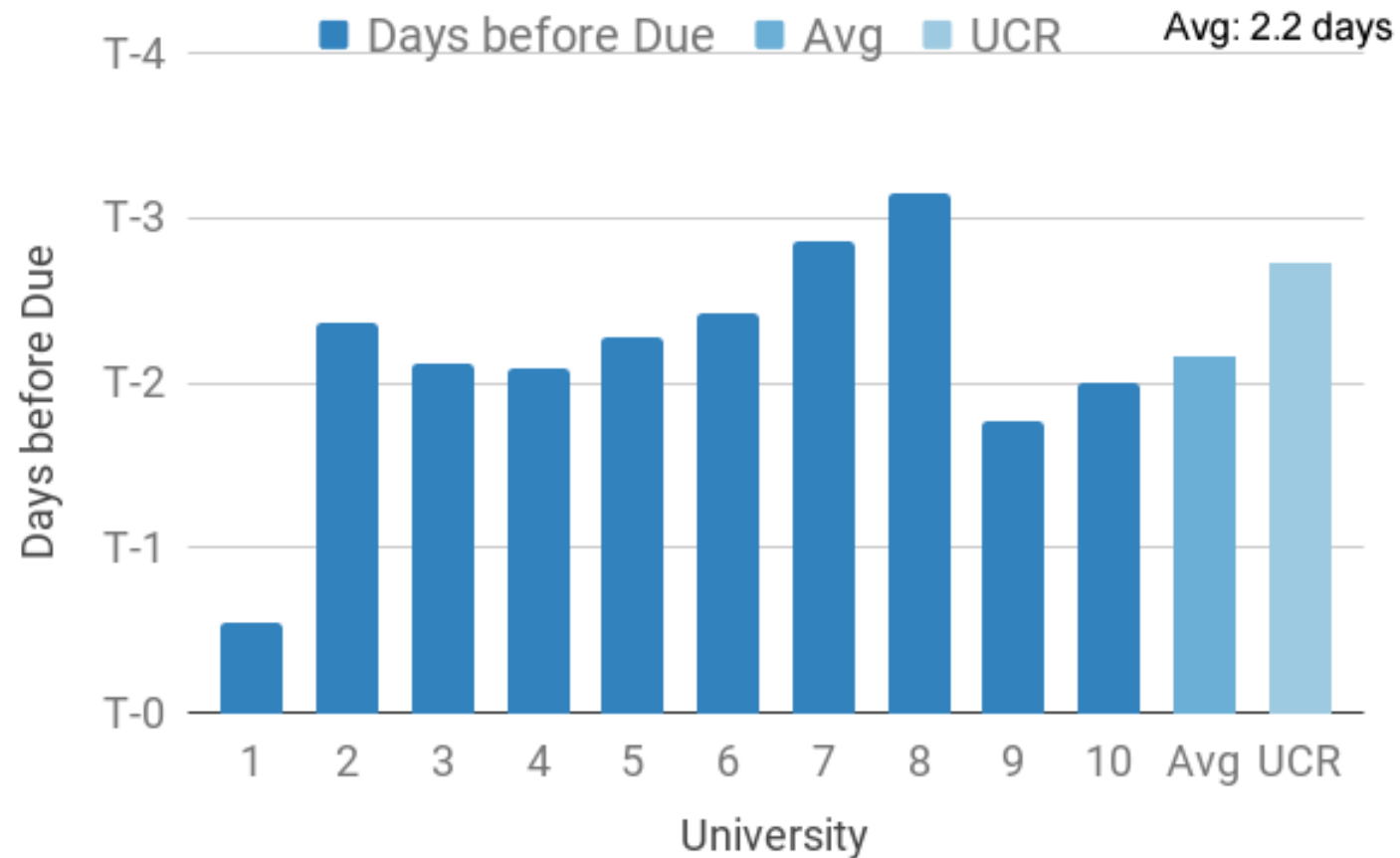
A: At least 12 min / MSP



UCR average time spent per MSP - 17 min / MSP

Q: How many days before the due date do students start working on MSPs?

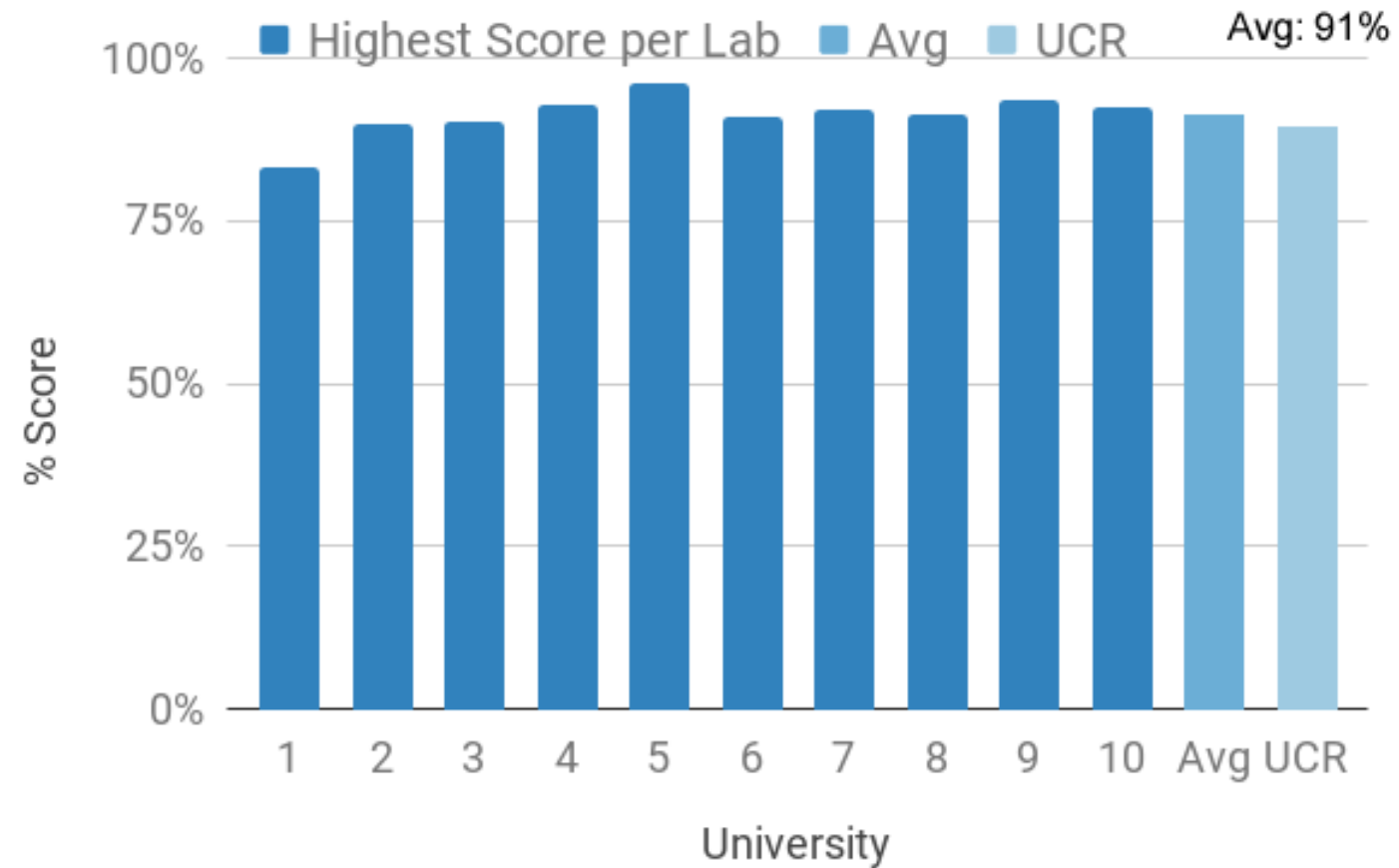
A: MSPs started 2.2 days before due date



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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