An Analysis of Using Coral Many Small Programs in CS1

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CS1 is difficult

- Problems in CS1
  - High student stress
  - Cheating
  - High DFW rates
- Reason
  - Technical challenges & nuances of learning commercial languages like C++, Python, and Java
- Goal
  - Reduce student stress & improve student experience
  - Our solution: hybrid Coral/C++ MSP teaching approach

```
#include <iostream>

using namespace std;

int main() {
   cout << “Hello World!”;

   return 0;
}
```

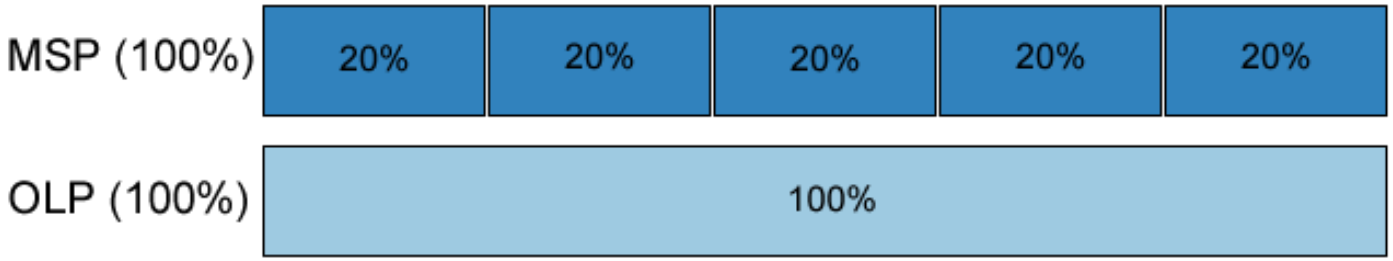
C++ source code for an introductory output program

Background – MSP teaching approach

- MSP - Many small programs
  - 5-7 programs per week
- Characteristics
  - Concise prompt
  - 20-50 lines of code (solution)
  - One topic per lab
- Benefits[1,2]
  - Earlier starts
  - Reduced stress
  - Additional practice

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

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



Background – Coral

- Coral: Ultra-simple code & flowchart language for learning programming
  - Web-based & Fully executable
  - Designed for college students
  - Pseudocode to resemble commercial languages

- Features
  - Supports only 7 instructions
  - Exactly one statement per line
  - Only integer and float data types
  - Requires no main() or include/use directives

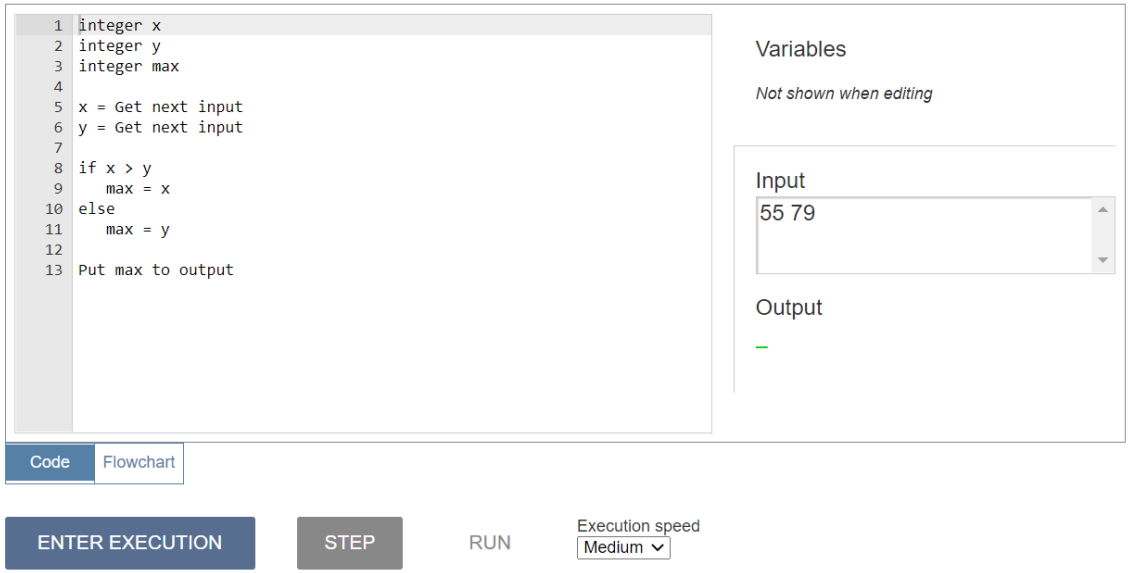
A. Edgcomb, F. Vahid, and R. Lysecky. Coral: An Ultra-Simple Language For Learning to Program, Proceedings of ASEE Annual Conference, 2019.

```
Put “Hello World!” to output
```

Coral source code for an introductory output program

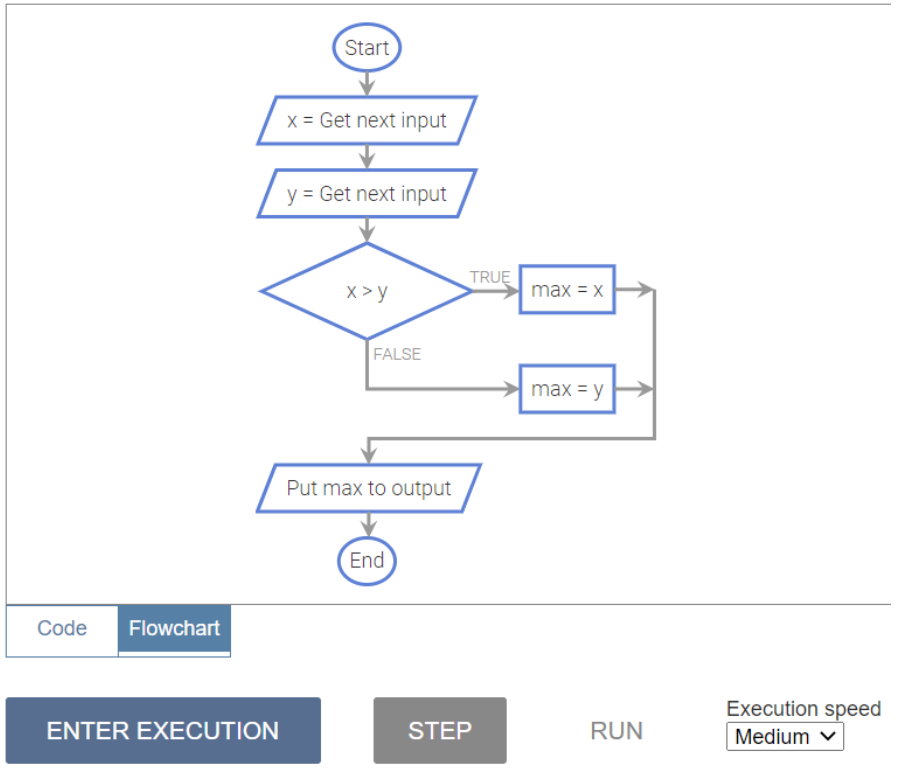
Background – Coral

Simulator



Coral's online web-based visual simulator

Simulator



Coral's visual flowchart simulator

Example: C++ vs. Coral MSP Solution

- Prompt: Write a program whose inputs are three integers, and whose output is the largest of the three values. Ex: If the input is 7 15 3, the output is: 15

C++

```
int num1;
int num2;
int num3;
```

```
cin >> num1;
cin >> num2;
cin >> num3;
```

```
if (num1 >= num2 && num1 >= num3) {
    cout << num1;
}
elseif (num2 >= num3) {
    cout << num2;
}
else {
    cout << num3;
}
```

Coral

```
integer num1
integer num2
integer num3
```

```
num1 = Get next input
num2 = Get next input
num3 = Get next input
```

```
if (num1 >= num2) and (num1 >= num3)
    Put num1 to output
elseif (num2 >= num3)
    Put num2 to output
else
    Put num3 to output
```

Methods

- Course details
  - Spring 2020 CS1 course (300-500 students)
  - 50/50 major and non-major students
  - zyBooks interactive textbook
  - C++ -- input/output, variables, expressions, branches, loops, functions, and vectors.

- Data collection
  - Gradebook
  - Surveys
  - Activity log file

	A	B	C	D	E	F	G
1	lab_id	user_id	timestamp	submission	zip_location	score	max_score
2	LAB: Sample 1	1103	1/1/2021 17:23	1	https://xyz.zip	8	10
3	LAB: Sample 1	1103	1/1/2021 17:32	0	https://xyz.zip		
4	LAB: Sample 2	1103	1/1/2021 18:11	0	https://xyz.zip		
5	LAB: Sample 3	1103	1/2/2021 12:00	1	https://xyz.zip	10	10
6	LAB: Sample 7	1103	1/2/2021 12:09	1	https://xyz.zip	2	10

Experiment Details

CS1 course at UCR during Spring 2020; 10 week quarter

Pure C++

2 sections; 196 students

Instructor 1

10 weeks C++

C++ Midterm

Same online textbook

Same topics

Same final exam

1 week for assignments / different release dates

Hybrid Coral/C++

1 section; 98 students

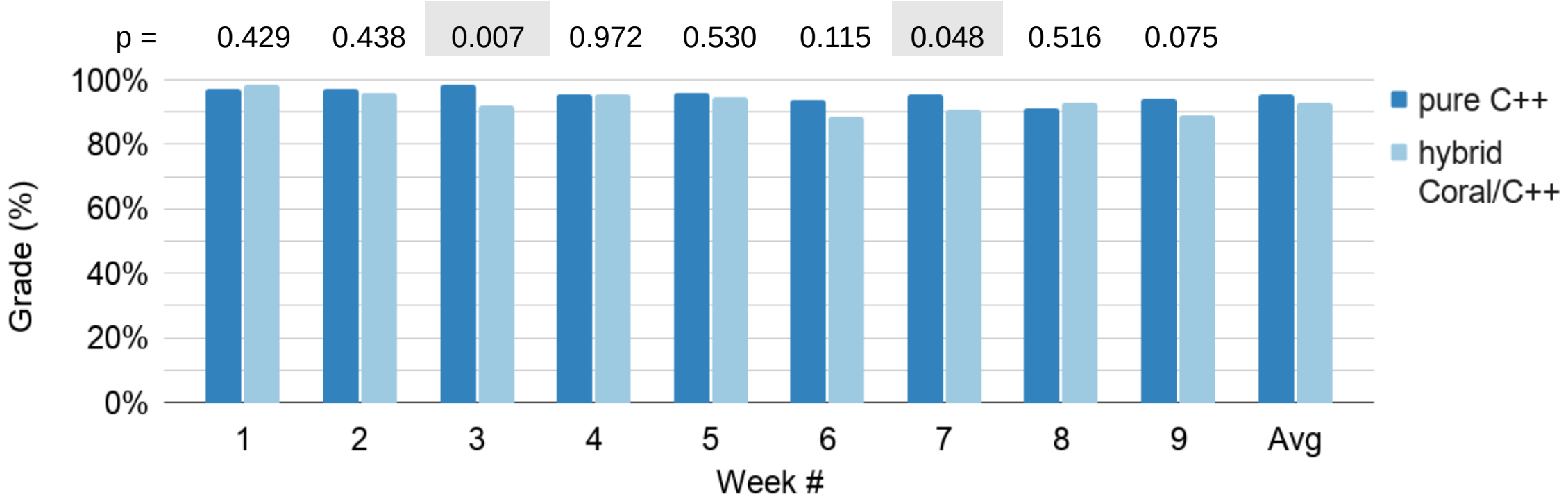
Instructor 2

3 weeks Coral / 7 weeks C++

Coral Midterm

Results: Grade performance (lab activities)

- Pure C++ group: 96% avg.
- Hybrid Coral/C++ group: 93% avg.



Results: Grade performance (class)

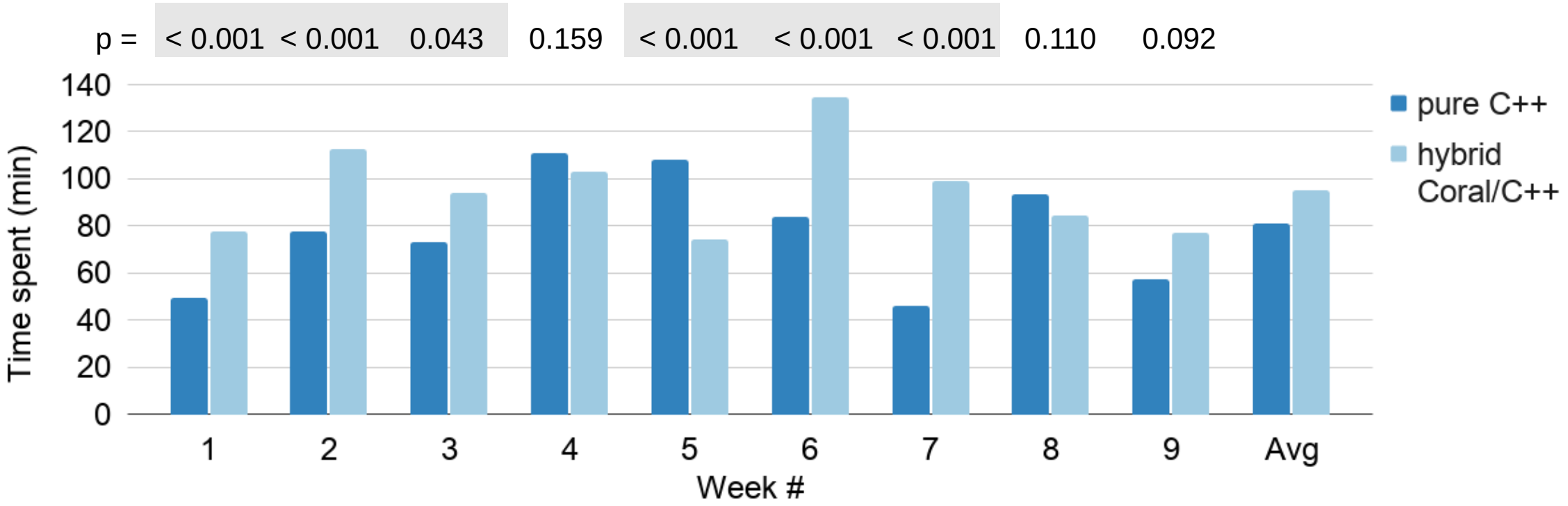
Table 1: Student grade performance on all categories of our CS1 class

Class category	Pure C++	Hybrid Coral/C++	p
Total class grade	88%	95%	< 0.001
Final exam	83%	88%	0.043
Midterm exam	83%	95%	< 0.001
Participation activities	94%	95%	0.482
Challenge activities	94%	95%	0.616
Lab activities	96%	93%	0.134

*Spring 2020 was start of pandemic

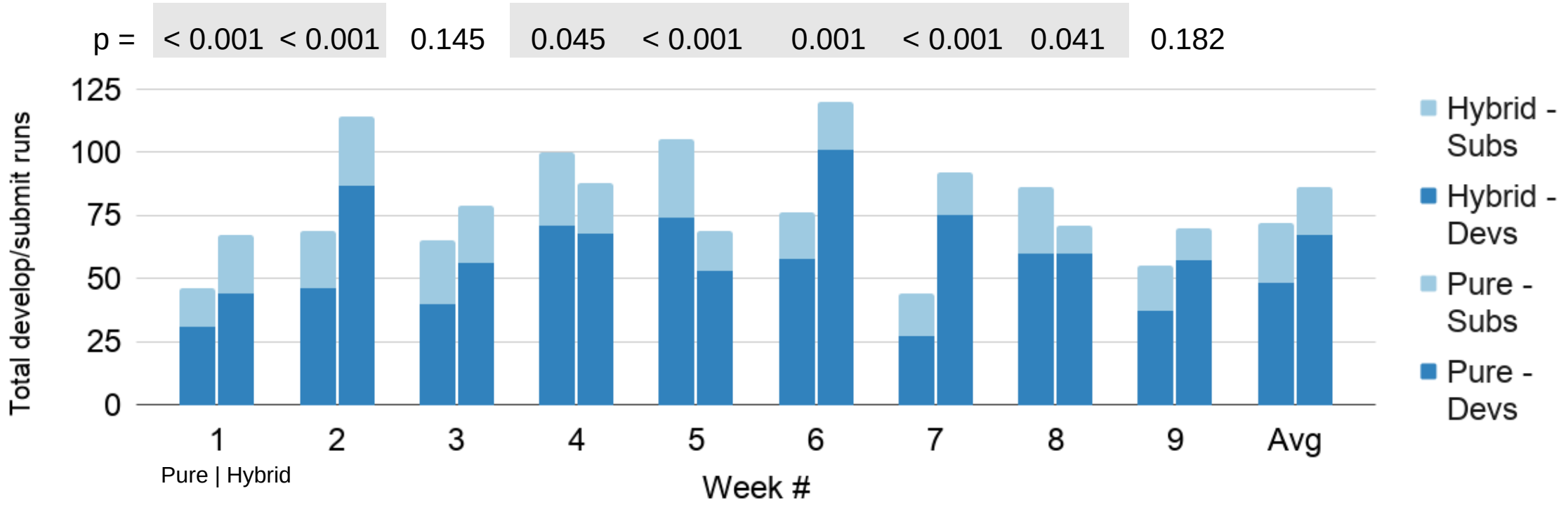
Results: Time spent

- Pure C++ group: 81 minutes avg.
- Hybrid Coral/C++ group: 91 minutes avg.



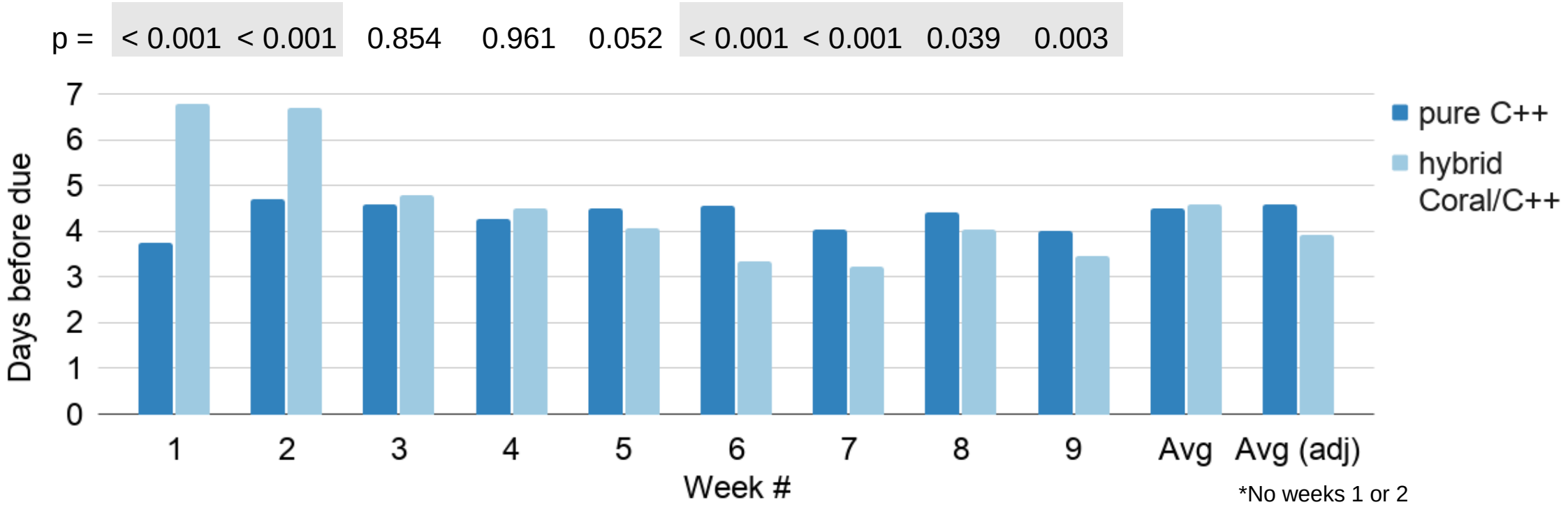
Results: Activity runs (develops & submits)

- Pure C++ group: 72 runs | 48 devs | 24 subs avg.
- Hybrid Coral/C++ group: 83 runs | 67 devs | 16 subs avg.



Results: Start date

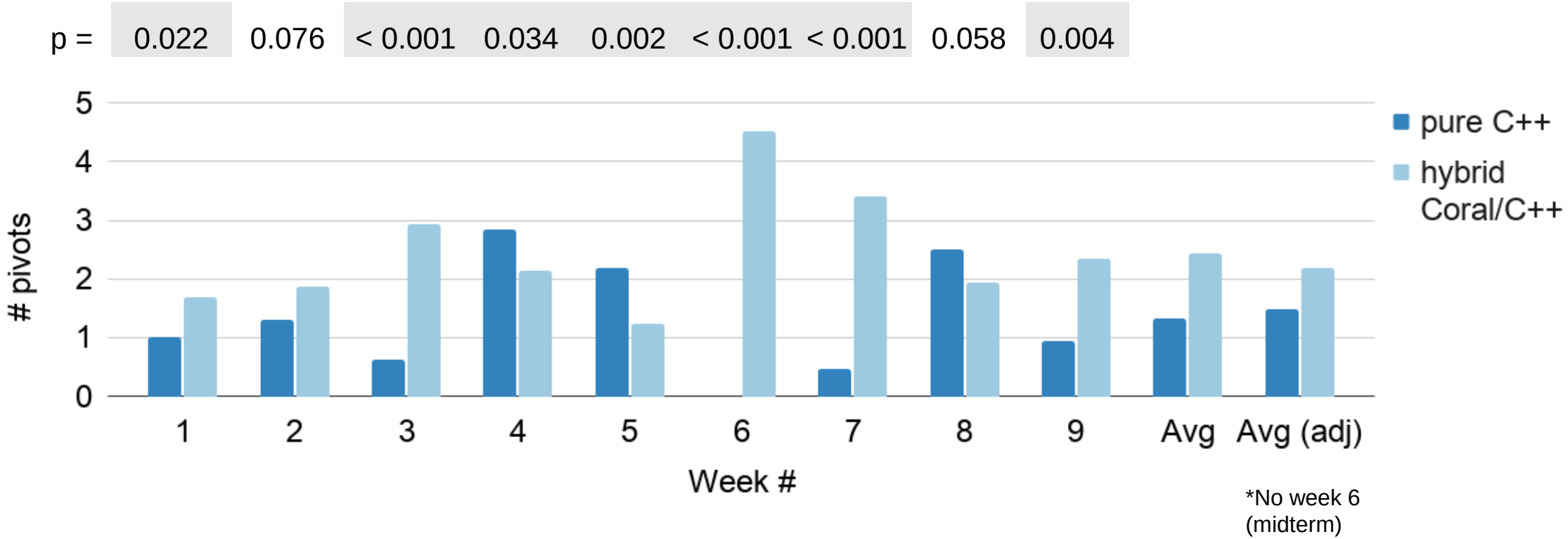
- Pure C++ group: 4.5 days / 4.8 days adj.
- Hybrid Coral/C++ group: 4.6 days / 3.9 days adj.



*No weeks 1 or 2 (grace period)

Results: Pivots

- Pure C++ group: 1.3 pivots / 1.5 pivots adj.
- Hybrid Coral/C++ group: 2.4 pivots / 2.2 pivots adj.

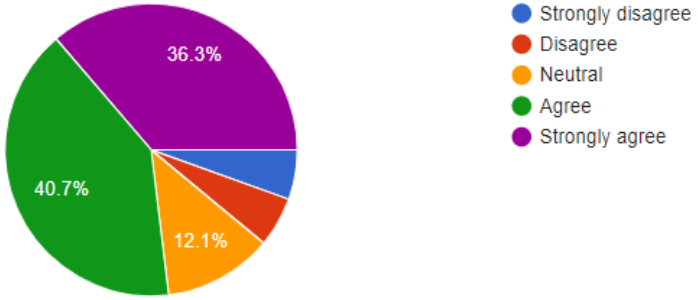


*No week 6 (midterm)

Results: Student surveys

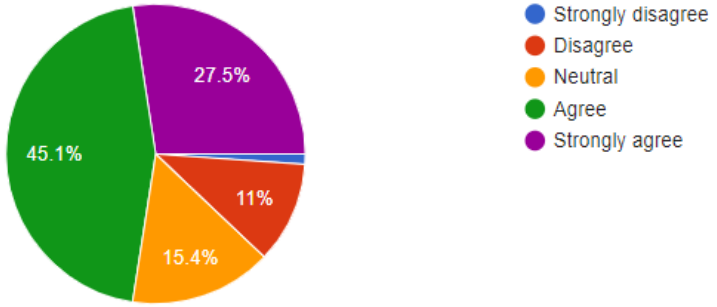
I enjoyed learning Coral

91 responses



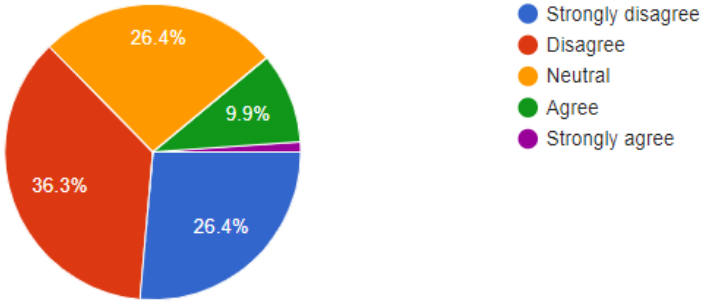
I think learning Coral first made C++ easier to learn

91 responses



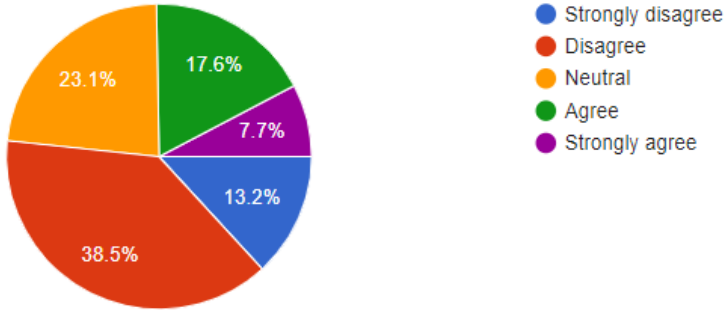
I found the transition from Coral to C++ difficult

91 responses



I would have preferred to learn C++ from the beginning of the course, without Coral

91 responses



Results: Student comments

- [Coral] made the transition extremely easy and I think learning C++ first would have confused me. Coral was good for visual learning (which applies to me) and it help me a lot.
- Coral was easier to learn initially than I think C++ would have been because its easier to identify my thought process of what I want my code to do in Coral than in C++
- Its nice in concept but a tad overwhelming only on the syntax side since its much more specific in C++
- If the goal is to teach students with absolutely no programming experience then it is good. However students with experience in engineering may find the approach dumbed down and less engaging. […]

Conclusion

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- Our experience
  - Similar high grade performance
  - Coral/C++ spent more time
  - Coral/C++ more activity
  - C++ group works earlier
  - Coral/C++ pivot more
- Student comments
  - Enjoyed the approach; could be slow for folks with prior coding experience
- *Not meant to conclude that one teaching approach is better, but both work

Simulator