A Hybrid Open/Closed Lab for CS 1

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CS 1

- Most CS1 offerings incorporate some kind of experiential learning elements
  - Students learn better by *doing* rather than listening
  - Many different ways to accomplish this
    - Open Lab vs. Closed Lab

CS 1 Labs

- Closed Lab
  - *required time*
  - students are all present in a computer lab or classroom that is equipped with the necessary hardware
  - students work through guided exercises individually or in groups and are supervised by an instructor or teaching assistant.

CS 1 Labs

- Open Lab
    - an [unconstrained time](#)
    - required resources (e.g. computers) are made available to students
    - attendance at specific times is [optional](#)
    - lab may or may not be monitored by tutors or teaching assistants

Introduction

- Drake University
  - A small, private liberal-arts college located in Des Moines, Iowa USA
  - No lab space

Growth of Computer Science and Data Analytics at Drake University
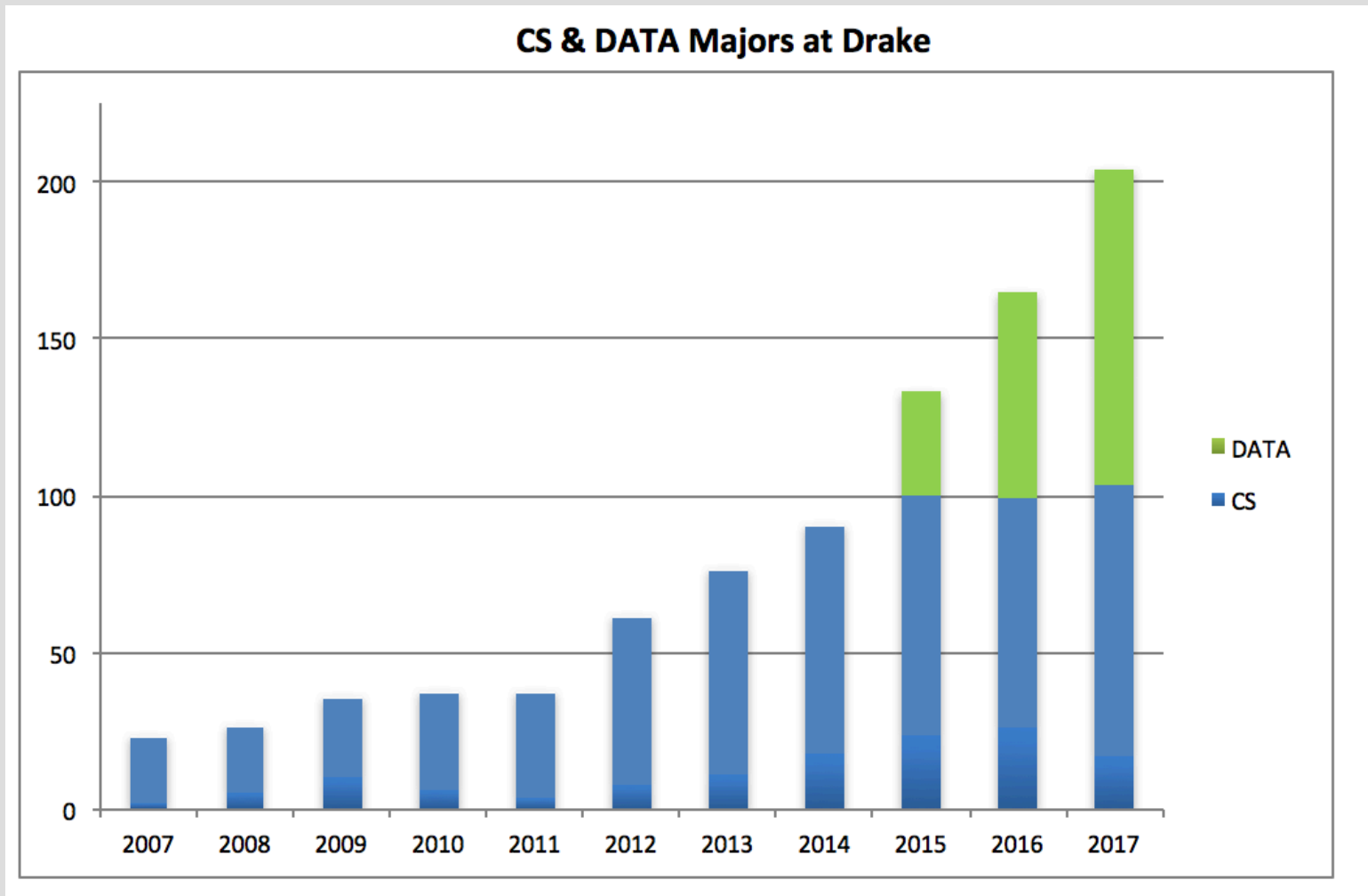
Introduction

- Drake University
  - A small, private liberal-arts college located in Des Moines, Iowa USA
  - No lab space
  - CS 1 course satisfies a general education requirement
    - Class size capped at 45 students
    - 3 sections offered each semester
    - No teaching assistants
    - Meets on Mondays, Wednesdays, and Fridays for 50 minutes

Hybrid Open/Closed Lab

- A "Hybrid" Lab is a set of instructions, demonstration of techniques, and examples of code presented in a written walkthrough format
  - Also consists of several challenges or exercises the students must complete to demonstrate competency

Hybrid Open/Closed Lab

- Similar to an Open Lab
  - Students are presented with the lab on Wednesday afternoon and are given the option of completing the challenges in lieu of attending a class period on Friday
- Similar to a Closed Lab
  - If the student does not have time or is unable to complete the lab, he or she is expected to attend the class session

Theoretical Advantages of Hybrid Labs

- Allows students to progress at their own pace
  - The lecture-based instruction format is not ideal for individual learning.
- Reward students who are proactive
  - Attendance is not mandatory for Friday class
- Reduce the number of students in the classroom on lab days
  - Individual questions are more manageable for the instructor

Hybrid Lab Example

Notice the user of `.lower()` in the following code:

```python
response = input("Enter some text: ")
print("your text in all lower case: ", response.lower())
```

When the user enters the text, it will be stored in the variable `response`. When `response` is output, it first calls the `.lower()` function, which turns all of the capital letter to lower case letters.

For example:
```
Enter some text: Hello this is SOMETHING
all lower case:  hello this is something
```

Challenge #1:
Consider the first few lines of the lab:

```python
if answer == "yes":
    print("Excellent! Here we go...")
else:
    print("um... we'll let's get started anyways...")
```

Hybrid Labs in Practice

- Is this a good idea?

- Are hybrid labs more effective than standard lecture?

- Fall of 2016, I taught two sections of CS 1
  - Fridays
    - One section was given the hybrid labs
    - One section was presented the material via lecture
  - Mondays and Wednesdays were the same between both sections
  - Both sections given the same exams, assignments, etc.

Pre-Semester Survey

- I was particularly interested in measuring students' attitudes and abilities related to course objectives before the semester
  - Questions from CAS (Computing Attitudes Survey)

- Likert-like scale:
  - Strongly Disagree (0)
  - Disagree (1)
  - Neutral (2)
  - Agree (3)
  - Strongly Agree (4)

Pre-Semester Survey Example Questions

- The subject of computer science has little relation to what I experience in the real world.

- I find the challenge of solving computer science problems motivating

- I prefer a classroom lecture format for learning

- I prefer a hands-on lab format for learning

Pre-Semester Survey Self-Reported Abilities

- Pre-Semester Survey

  - Students rate on a scale from 0 to 5 how confident they felt they could answer questions related to the objectives for the course

Pre-Semester Survey Example Questions

- Write a computer program that effectively uses if statements and if-else statements.

- Write a computer program that uses loops and nested loops.

- Write a computer program that uses a method or function, passes parameters to the function, and returns a value.

- Write a computer program that uses a file to read or write information

Results

- Post-semester survey results indicated a *favorable* influence of the course on the attitudes and beliefs students have regarding computer science

- Notable differences in which the lab section responses agreed <u>*more strongly*</u> than lecture section

  - *I enjoy solving computer science problems*

  - *I find the challenge of solving computer science problems motivating*

  - *I am interested in learning more about computer science*

Results

- Post-semester survey results indicated a *favorable* influence of the course on the attitudes and beliefs students have regarding computer science

- A few exceptions:

  - Slight decrease (3.58 to 3.44) in the lab section for question: *Tools and techniques from computer science can be useful in the study of other disciplines*

  - Slight increase (0.72 to 0.77) in lecture section for question: *There is usually only one correct approach to solving a computer science problem.*
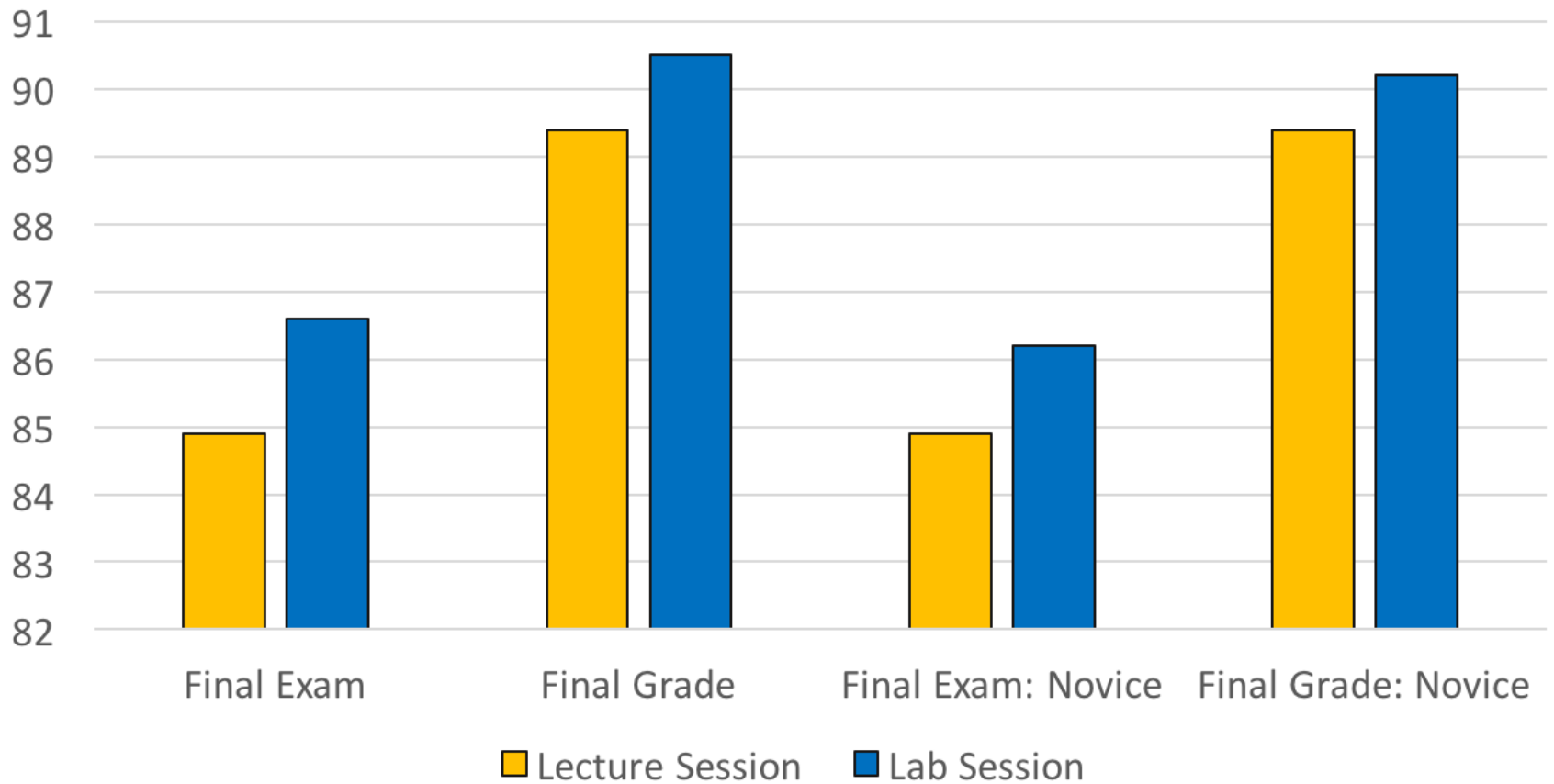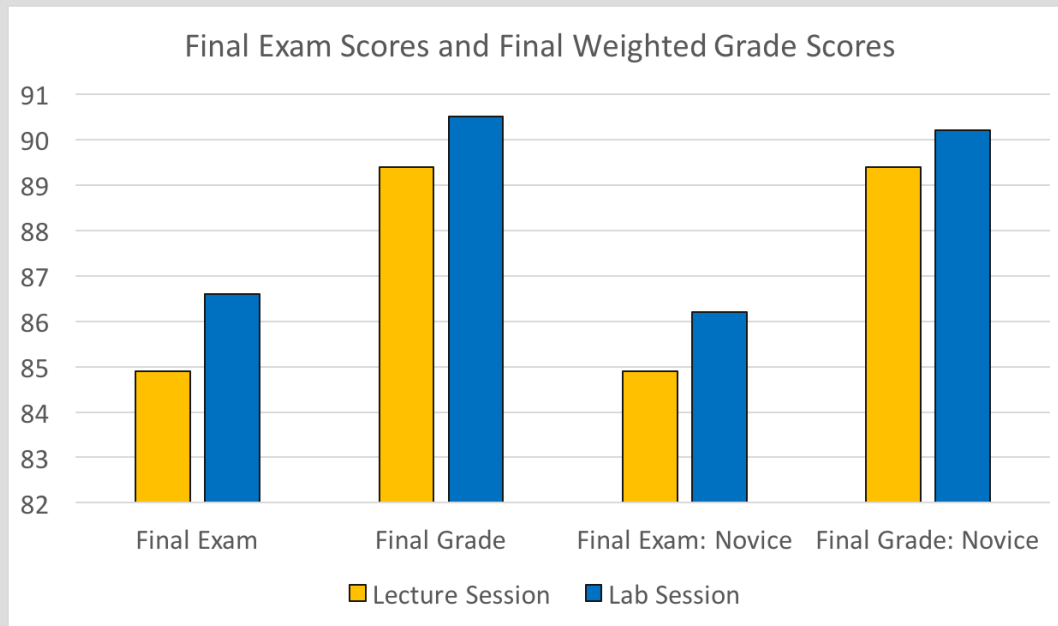
Self-Reported Abilities

- The self-reported abilities allowed us to identify students with some experience programming
  - 7 students in the lab section
- Comparing only the novice students in each section allowed us to compare the effectiveness of the method

Results

- Entire Class:
  - Final Exam Percentages:
    - Lecture: 84.9%   Lab: 86.6%
  - Final Course Percentages:
    - Lecture: 89.4%   Lab: 90.5%
- Novice Programmers:
  - Final Exam Percentages:
    - Lecture: 84.9%   Lab: 86.2%
  - Final Course Percentages:
    - Lecture: 89.4%   Lab: 90.2%

Final Exam Scores and Final Weighted Grade Scores

Final Exam Scores and Final Weighted Grade Scores

Legend: Lecture Session (yellow), Lab Session (blue)

Categories: Final Exam, Final Grade, Final Exam: Novice, Final Grade: Novice

- While the lab section out-performed the lecture section by one to two percent on each of the midterm and final exams, no statistically significant differences were found when comparing the two sections and controlling for gender, year of study, or programming experience.
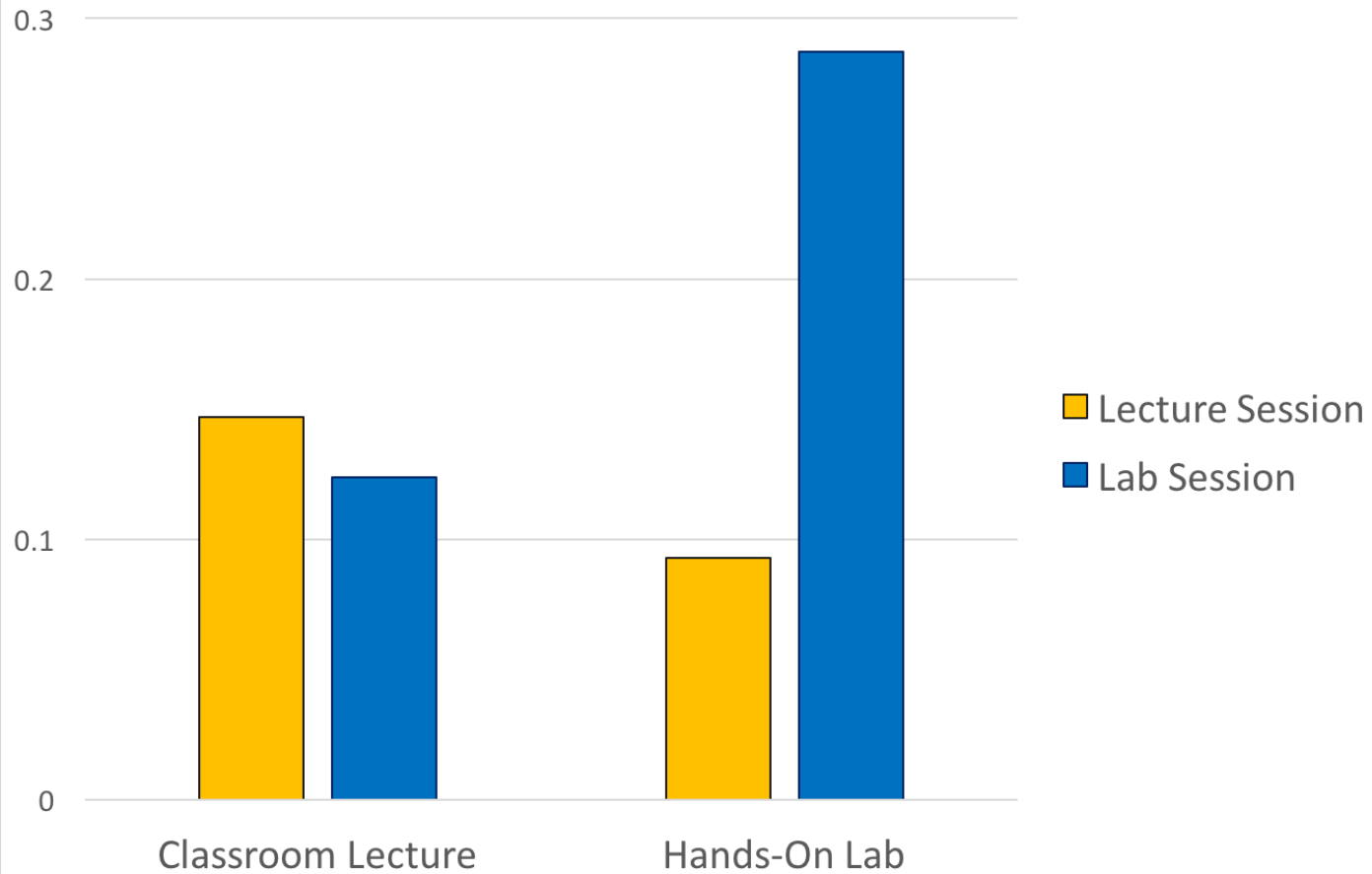
Conclusions

Conclusions

- Result #1: Students appreciate the hybrid lab format.
  - Recall from the pre-semester survey, we asked students to what extent they agreed with the following statements:
    - I prefer a classroom lecture format for learning
    - I prefer a hands-on lab format for learning
  - We repeated this as part of the post-semester survey
    - The relative increase of agreement for the hands-on learning for the lab section was much greater than the others

Post-Semester Increase in Survey Question: "I prefer ___ for Learning"

Conclusions

- Result #2: Students are more engaged with the hybrid lab format.
  - One of the main advantages of the hybrid lab format is the unstructured nature of the lab, which allows for more hands-on exploration and engagement with the material.

Conclusions

- We obtained statistically significant differences between the lab and lecture sections on the following post-semester survey questions measuring attitudes towards computer science

  - *I enjoy solving computer science problems.*
  - *I find the challenge of solving computer science problems motivating.*
  - *I am interested in learning more about computer science."*

- Each of these statements were more strongly agreed with by the lab section.

Conclusions

- Result #3: The labs allowed for a more tailored, individualized instruction for a variety of student abilities

  – The most significant drawback with the lecture format of delivering information to a group of students is that not all students learn at the same pace.

Conclusions

- Result #3: The labs allowed for a more tailored, individualized instruction for a variety of student abilities
  - Lecture student comments
    - *"sometimes information was rushed."*
    - *"class was a bit slow..."*
    - *"I wish I was in the Friday lab section so I could practice more rather than sit in a lecture."*

Conclusions

- Result #3: The labs allowed for a more tailored, individualized instruction for a variety of student abilities
  - Lab student comment
    - *"The combination of lecture and hands-on learning helped to understand both concepts and applications of the material."*

Conclusions

- Result #4: The lecture section students learned the material and had a better rapport with the instructor.

- The lecture section learned the same material to a comparable degree as the students from the lab section.

    - Class dynamics and interactions amongst students and the instructor were more lively during the lecture section than during the lab section.

Future Work

- How much individual work vs. classroom work is beneficial for novice programmers?

- Extend to other classes?

Summary

- Hybrid Labs are appreciated by students to be an effective way of engaging CS 1 material

  - Allow for a tailored, individualized instruction for a variety of student abilities

- In the future, we plan to offer all sections of CS 1 using hybrid labs and will consider extending the use of hybrid labs to additional courses.

Questions?

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